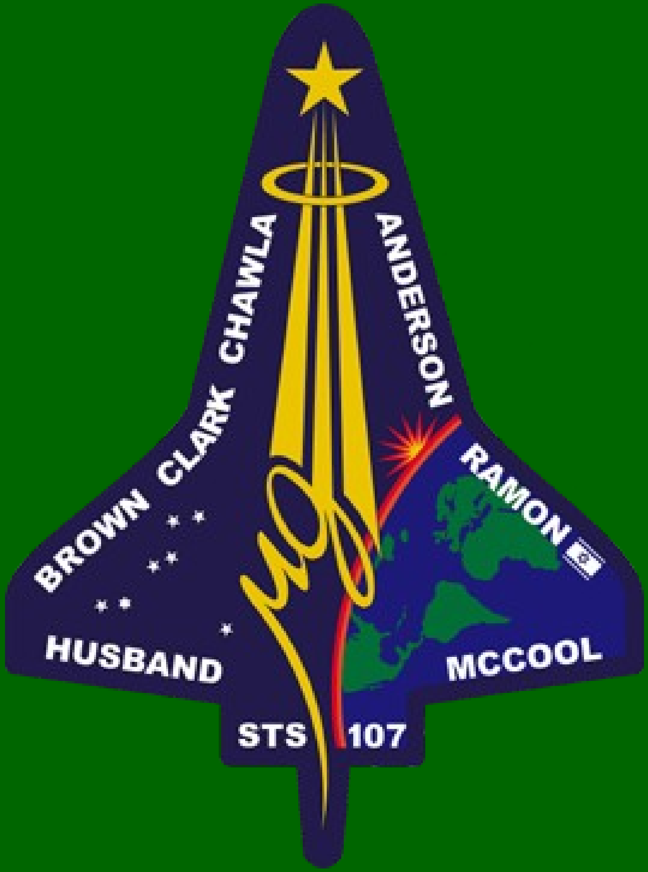
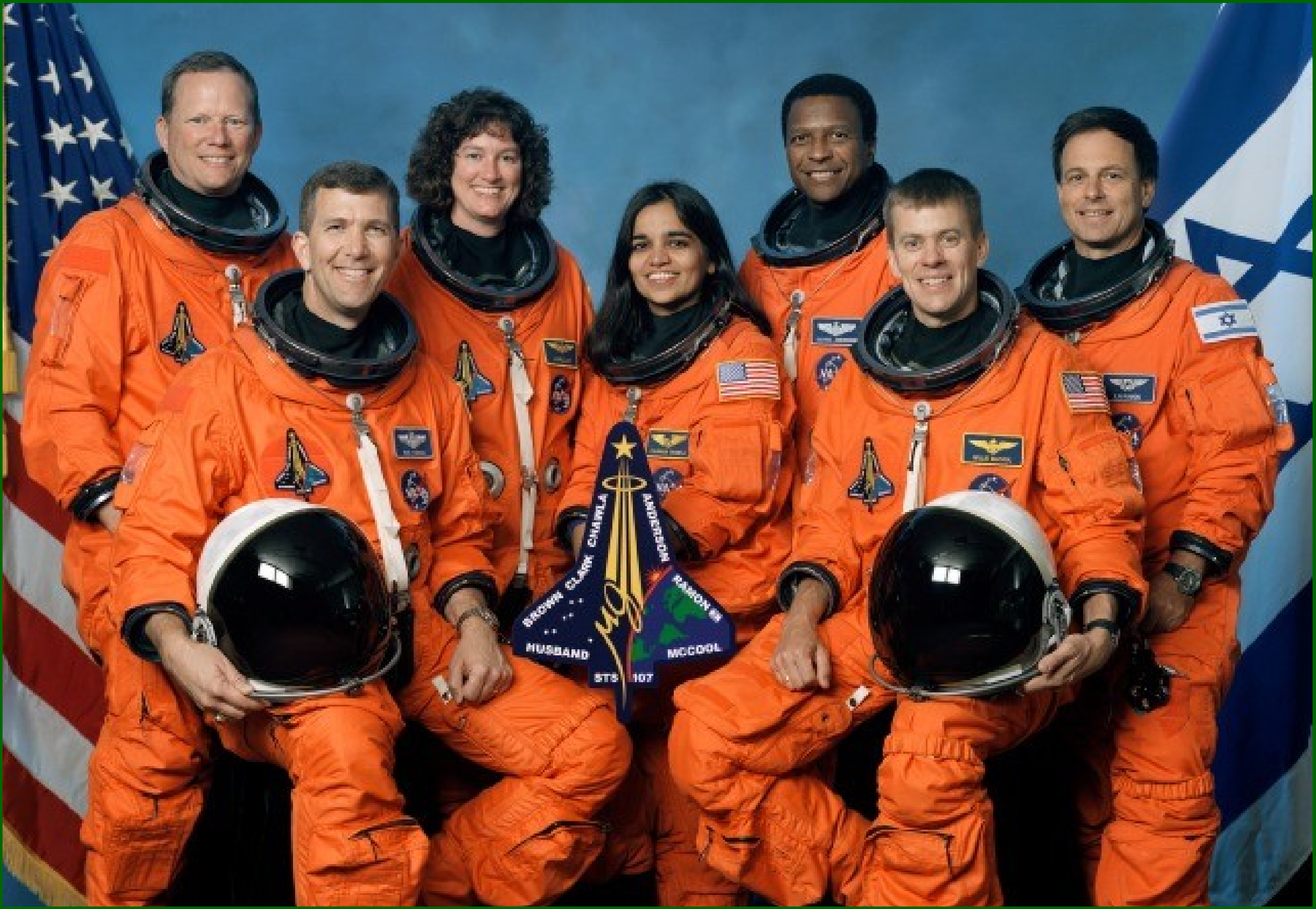
STS-107
Space Shuttle Columbia Recovery Operation
February 1 – May 10, 2003


BROWN
CLARK
CHAWLA
ANDERSON
RAMON
HUSBAND
MCCOOL
STS
107

STS-107 Mission

- 16 day science mission
- Over 70 experiment payloads in…
  - Space Product Development
  - Fundamental Space Biology
  - Bioastronautics
  - Physical Sciences

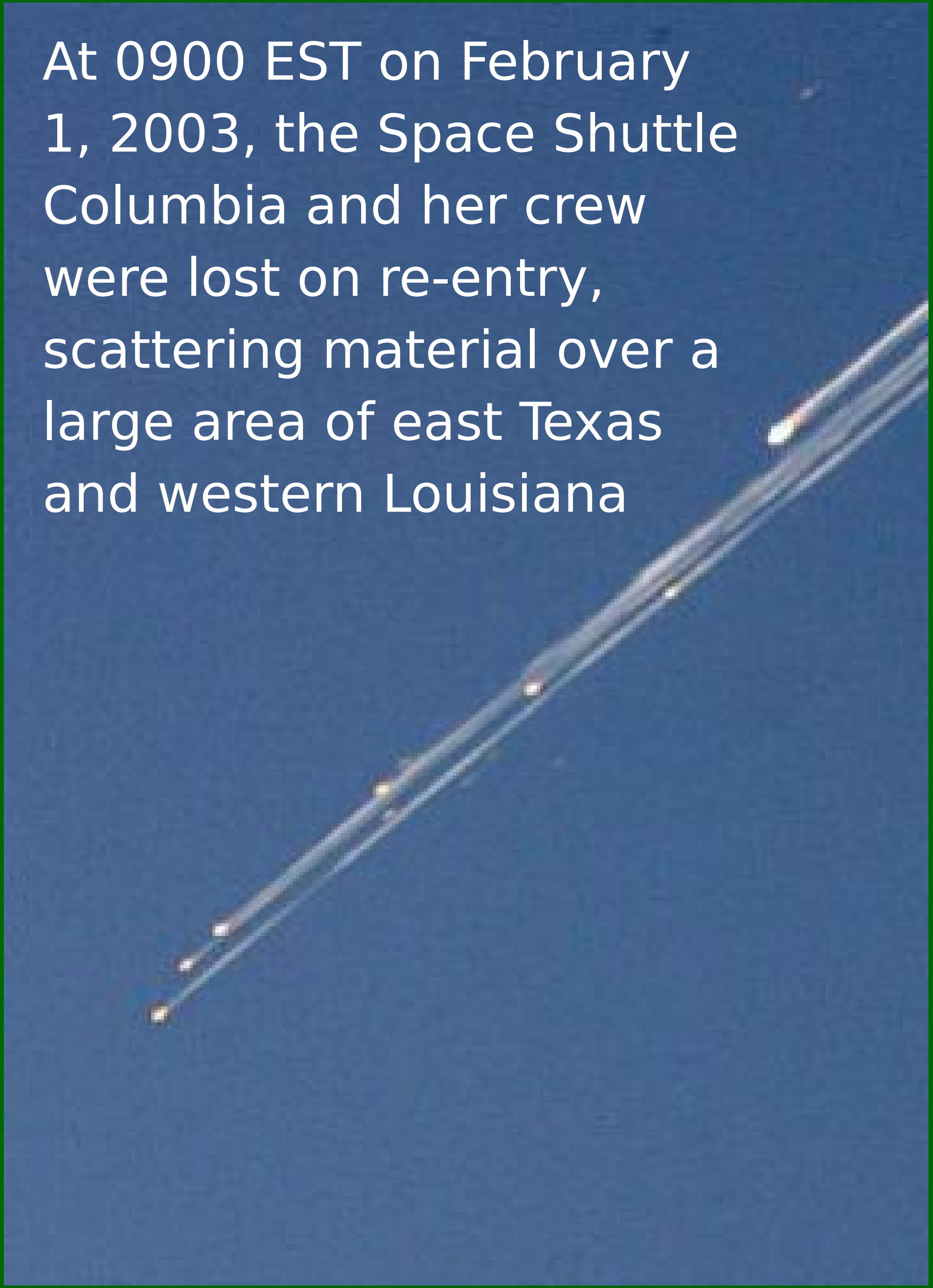

BROWN
CLARK
CHAWLA
ANDERSON
RAMON
HUSBAND
MCCOOL
STS 107

David Brown Rick Husband Laurel Clark Kalpana ChawlaMichael AndersonWillie McCool Ilan Ramon

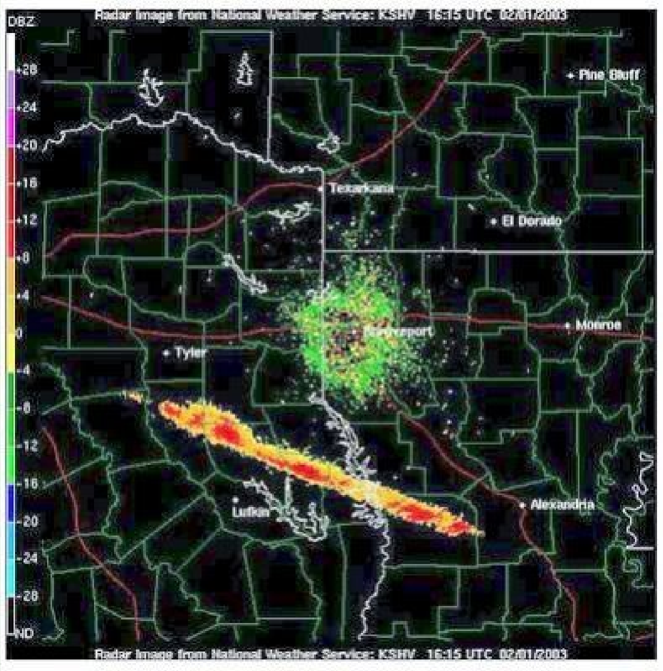
STS-107 Crew

STS-107 Launch

January 16, 2003

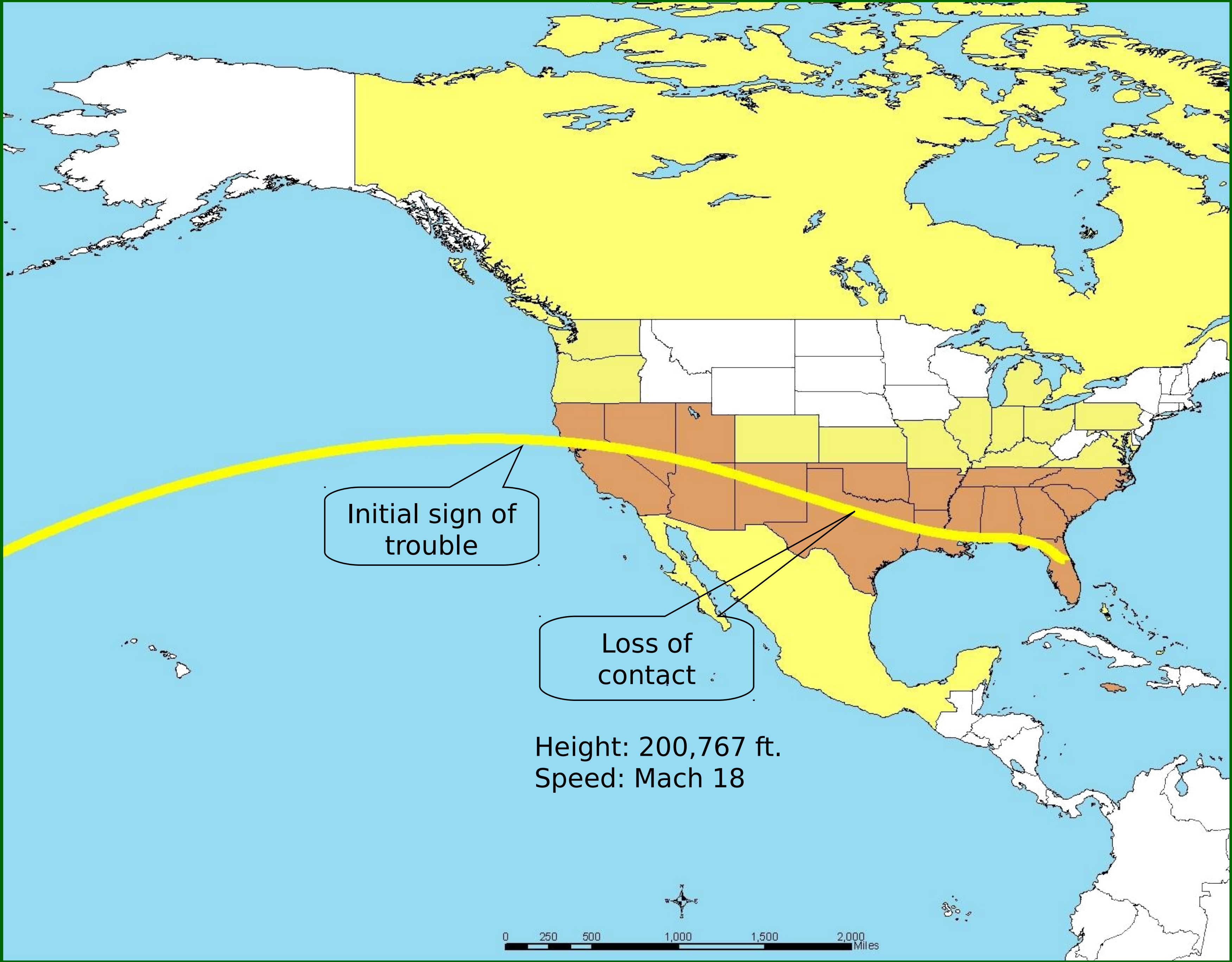


At 0900 EST on February 1, 2003, the Space Shuttle Columbia and her crew were lost on re-entry, scattering material over a large area of east Texas and western Louisiana


Radar Image from National Weather Service: KSHV 16:15 UTC 02/01/2003
DBZ
+28
+24
+20
+16
+12
+8
+4
0
-4
-8
-12
-16
-20
-24
-28
ND
Pine Bluff
Texarkana
El Dorado
Shreveport
Monroe
Tyler
Lufkin
Alexandria
Radar Image from National Weather Service: KSHV 16:15 UTC 02/01/2003

NASA
CSA ASC
GMT
MET
032:14:15:04+
015:22:36:04+
S3ND TDRS->MILA
00:00:00-
MCC
Mission Control Cen
ENTRY DIGITALS (version 2.1.3)
ENTRY GROUNDTRACK
TRAJECTORY
GUIDANCE NAVIGATION

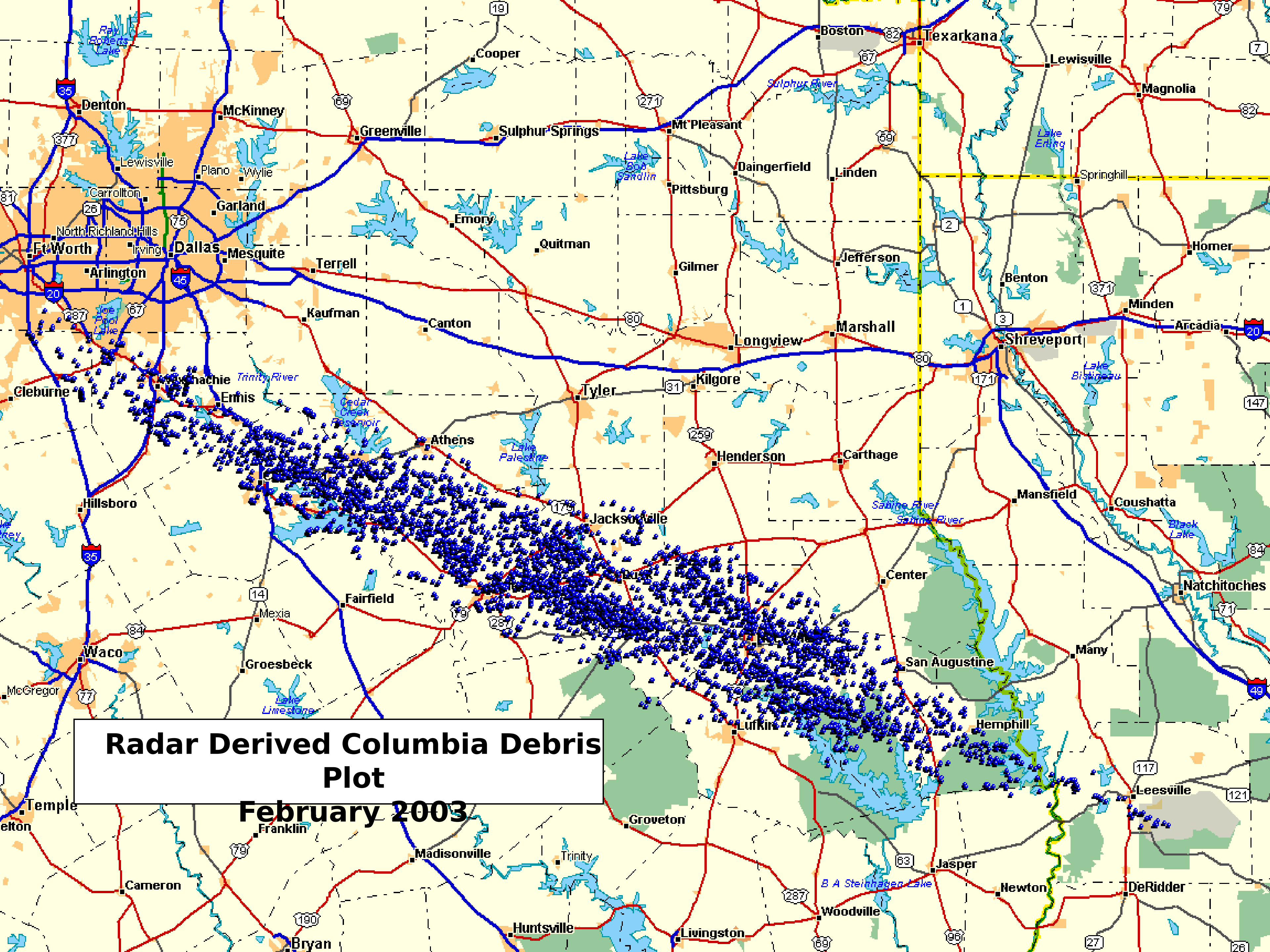
Mission Control - Johnson Space Center


N
W
E
S
0
250
500
1,000
1,500
2,000
Miles

Initial sign of trouble

Loss of contact

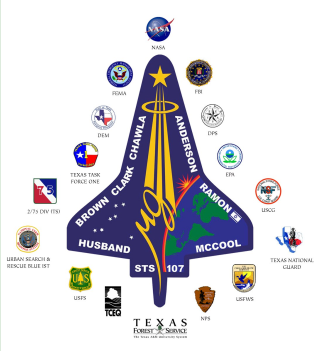
Height: 200,767 ft.
Speed: Mach 18



Radar Derived Columbia Debris Plot

February 2003

Ray Roberts Lake
Denton
McKinney
Greenville
Cooper
Sulphur Springs
Mt Pleasant
Boston
Texarkana
Lewisville
Magnolia
Sulphur River
Lake Bob Sandlin
Daingerfield
Linden
Lake Erling
Springhill
Plano
Wylie
Carrollton
Garland
Pittsburg
Emory
Quitman
North Richland Hills
Ft Worth
Irving
Dallas
Mesquite
Arlington
Terrell
Gilmer
Jefferson
Homer
Benton
Minden
Joe Pool Lake
Kaufman
Canton
Marshall
Longview
Shreveport
Arcadia
Lake Bistineau
Waxahachie
Trinity River
Cleburne
Ennis
Cedar Creek Reservoir
Tyler
Kilgore
Athens
Lake Palestine
Henderson
Carthage
Hillsboro
Jacksonville
Sabine River
Mansfield
Coushatta
Black Lake
Center
Natchitoches
Mexia
Fairfield
Waco
Groesbeck
McGregor
San Augustine
Many
Lake Limestone
Lufkin
Hemphill
Leesville
Temple
Belton
Franklin
Groveton
Madisonville
Trinity
Jasper
Cameron
B A Steinhagen Lake
Newton
DeRidder
Woodville
Huntsville
Livingston
Bryan


NASA
FEMA
FBI
DEM
DPS
TEXAS TASK FORCE ONE
EPA
2/75 DIV (TS)
USCG
BROWN CLARK CHAWLA
ANDERSON
RAMON
HUSBAND
MCCOOL
STS 107
URBAN SEARCH & RESCUE BLUE IST
TEXAS NATIONAL GUARD
USFS
TCEQ
NPS
USFWS
TEXAS FOREST SERVICE
The Texas A&M University System

Major Multi-Agency Response

- President Bush issued emergency declarations for Texas and Louisiana
- FEMA was the Lead Federal Agency under the FRP
- Disaster Field Offices (DFO’s) were established in Lufkin, Ft. Worth, and Barksdale AFB, LA
- NASA, FBI, EPA, USFS, and TFS in lead roles
- More than 450 federal, state, and local agencies, volunteer groups, and private organizations responded with personnel, supplies and equipment
- Over 25,000 personnel were involved in the response and recovery effort

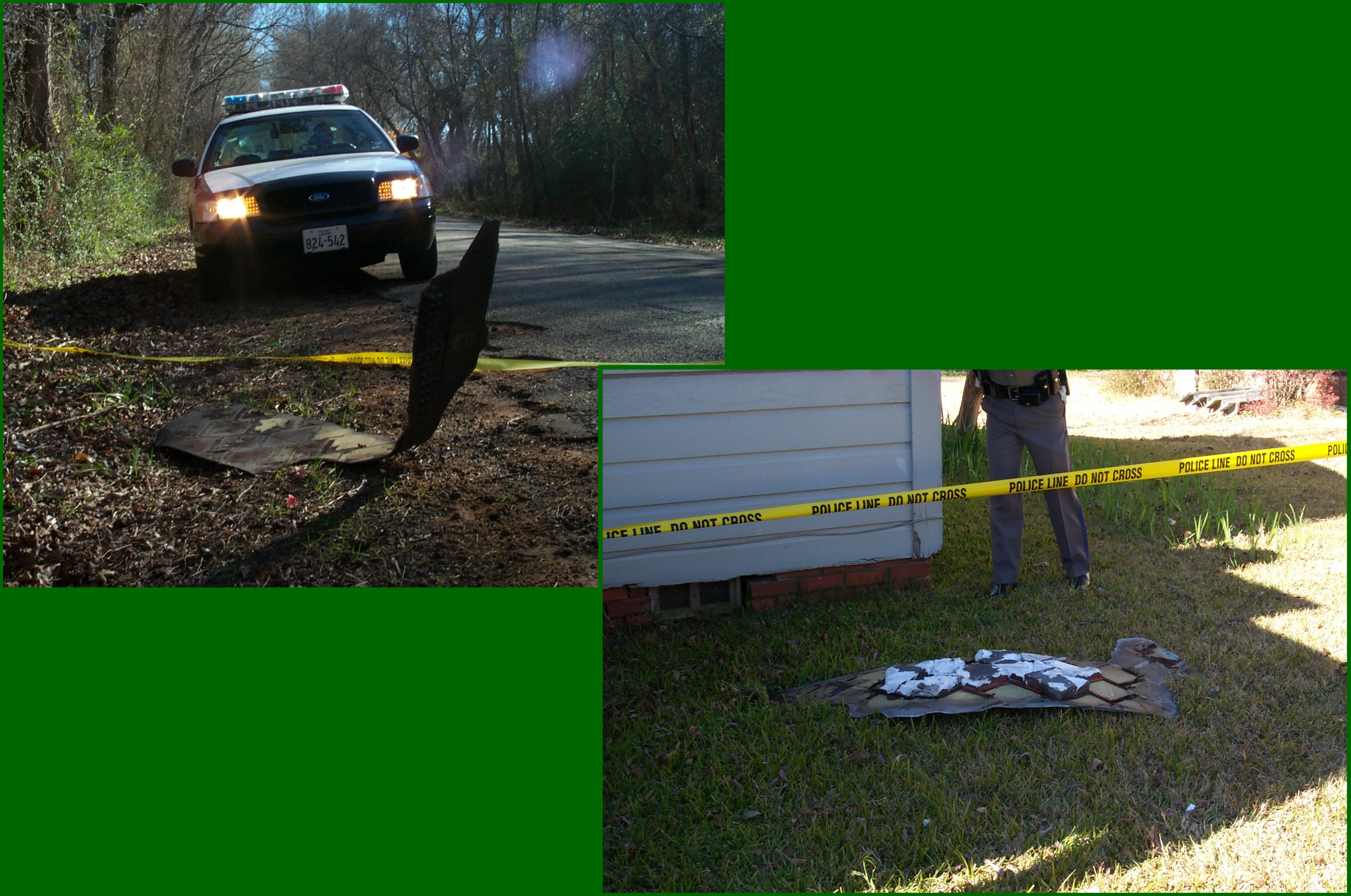
Operational Goals

- Ensure Public Safety
- Recover the Crew
- Retrieve Evidence
- Provide Public Assistance

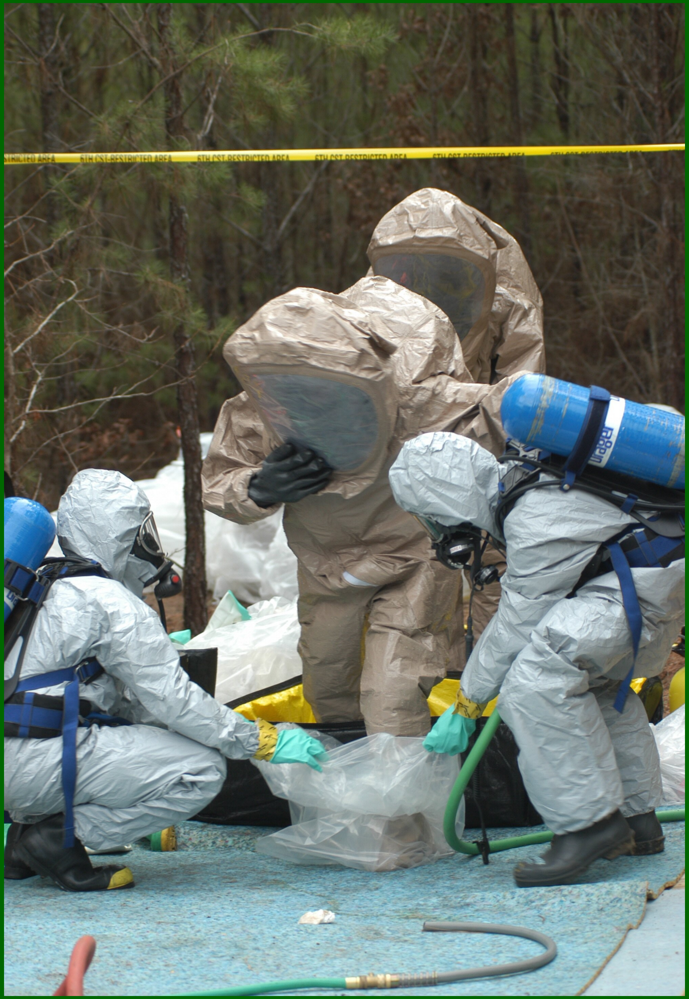
NASA
FEMA
FBI
DEM
DPS
TEXAS TASK FORCE ONE
EPA
2/75 DIV (TS)
USCG
URBAN SEARCH & RESCUE BLUE 1ST
TEXAS NATIONAL GUARD
USFS
TCEQ
NPS
USFWS
TEXAS FOREST SERVICE
BROWN
CLARK
CHAWLA
ANDERSON
RAMON
HUSBAND
MCCOOL
STS 107

Goal 1: Ensure Public Safety

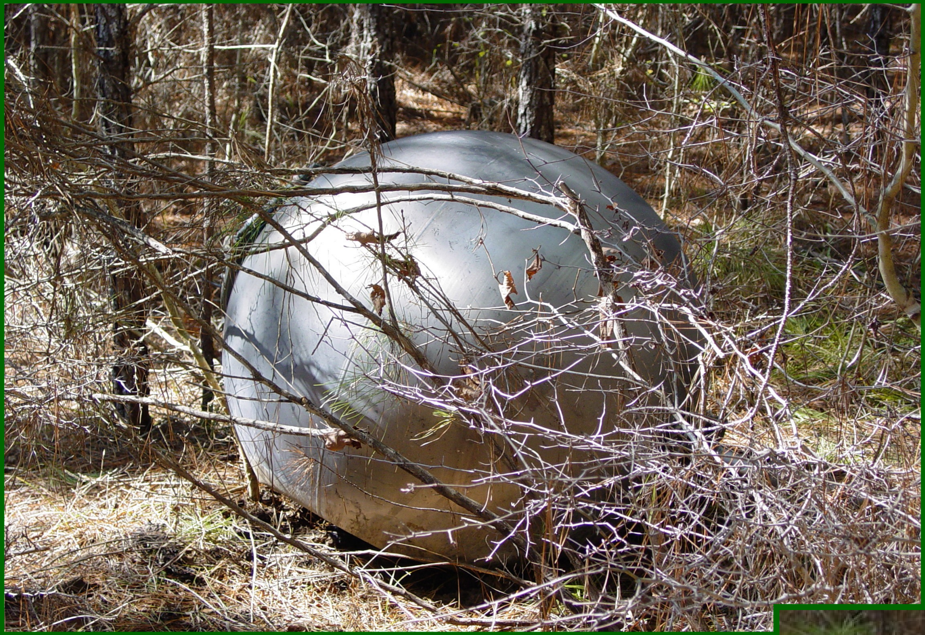
- Secure debris areas
- Mitigate hazardous materials
- Establish telephone hotline
- Develop database for citizen calls and retrieved material
- Coordinate GIS assets and develop products
- Remote Sensing products and analysis


824-542
POLICE LINE DO NOT CROSS

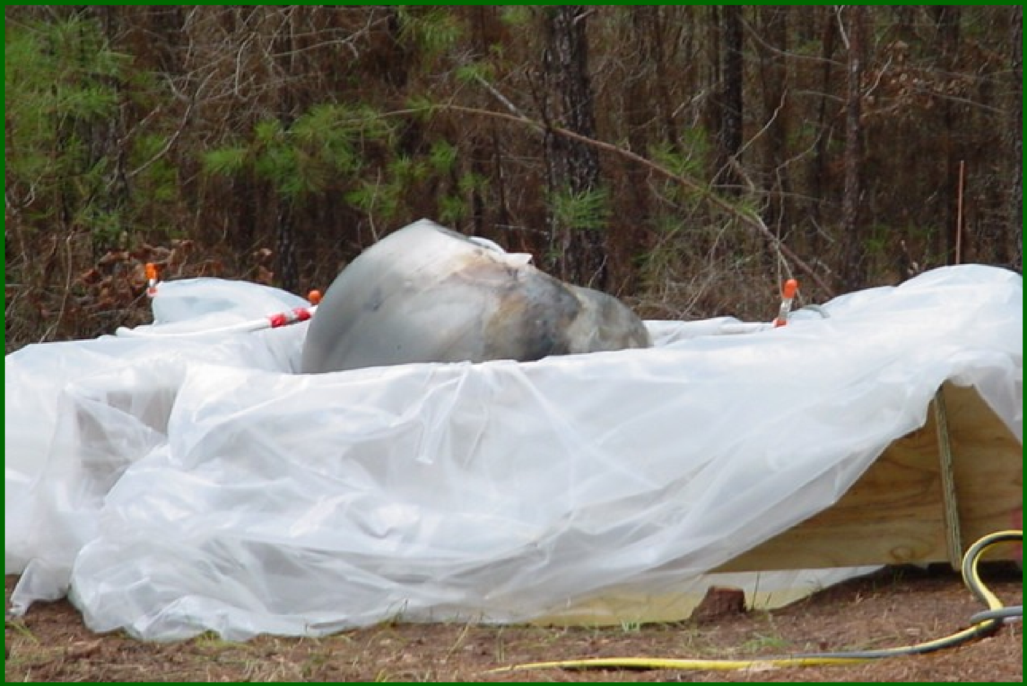
Department of Public Safety Secured Area



Hazmat Responses



Monomethyl Hydrazine Spherical Tank



Decontamination Setup

Telephone Hotline

- Over 12,000 calls in 100 days
- Calls from throughout United States
- Reports of material locations from citizens and local public officials

Master Database and PDA Sync

Interagency GIS Laboratory

Goal 2:
Crew Recovery

- Recovery of all crew members was accomplished within the first two weeks of the incident.
- The crew funeral and memorial services have been completed.
- Plans are underway for a permanent memorial at Arlington National Cemetery.

Goal 3: Retrieve Evidence

NASA
FEMA
FBI
DEM
DPS
TEXAS TASK FORCE ONE
EPA
2/75 DIV (TS)
USCG
URBAN SEARCH & RESCUE BLUE IST
TEXAS NATIONAL GUARD
USFS
TCEQ
NPS
USFWS
TEXAS FOREST SERVICE
CHAWLA
ANDERSON
CLARK
BROWN
RAMON
HUSBAND
MCCOOL
STS 107

- Ground search
    - Phase 1 – Collaborative effort by federal, state, local, and volunteer assets
    - Phase 2 – Wildland fire service assumed incident management and provided crews
- Air search
- Water search

Volunteer Search Efforts

800 Army National Guard Searchers

Searching the Big Thicket Wilderness Area

Volunteer Feeding Effort in Hemphill, TX

Support from American Red Cross, Salvation Army, and local companies

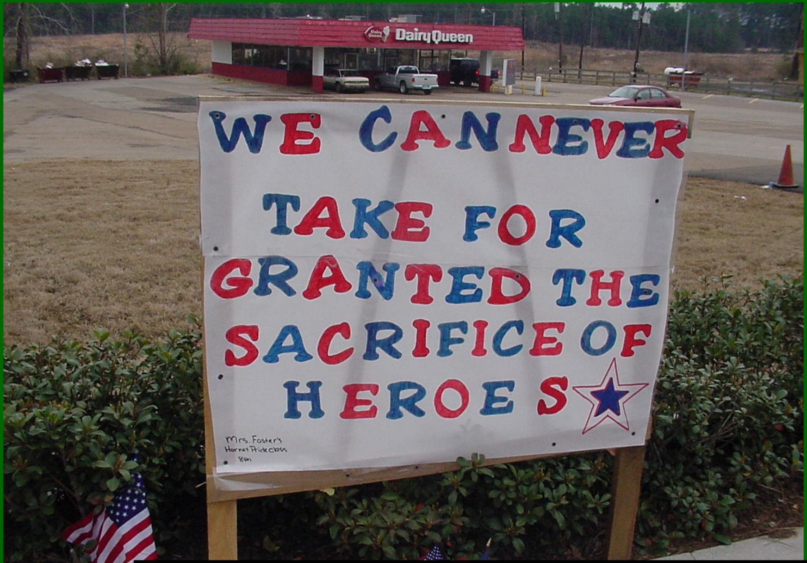
American
Red Cross
Disaster R
2125
Ozarka

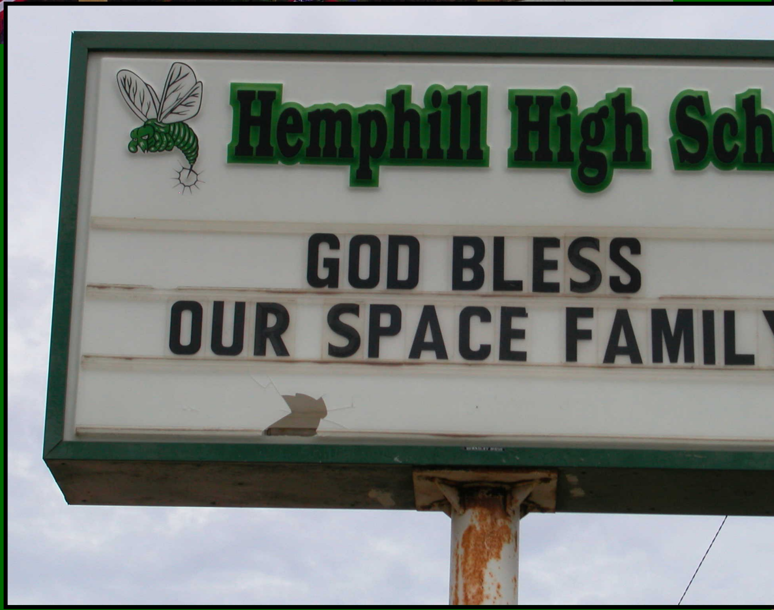
CARRIER
54500
Tyson
SOS
SHARE OUR STRENGTH
PARTNERS IN THE FIGHT
AGAINST HUNGER
It's wh
3060
53'

Television
Film
Audio
Satellite
New Media
WASHINGTON, D.C.
NORTH CAROLINA
KENTUCKY
FLORIDA
ATLANTA
DALLAS
Atlanta, GA

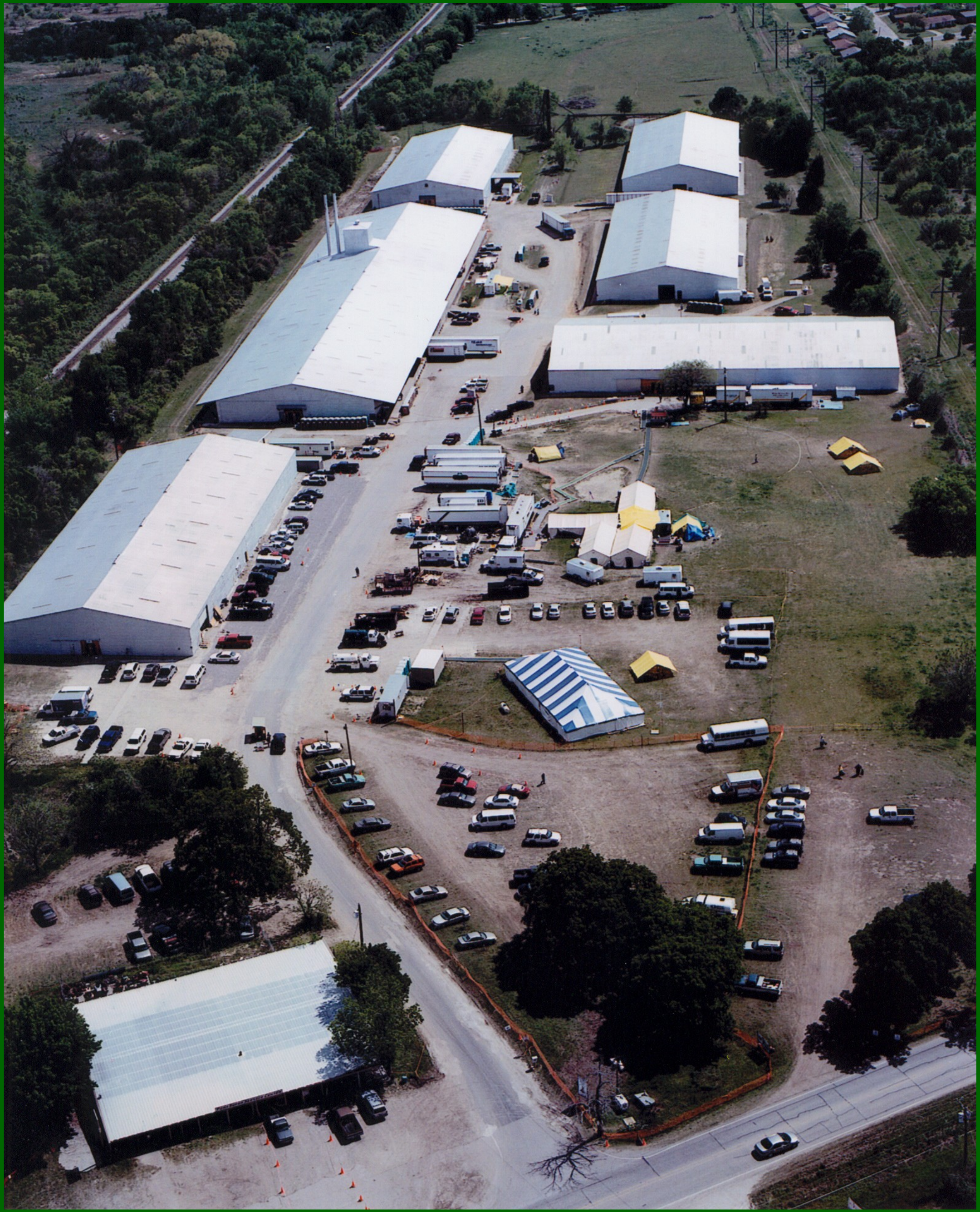
Substantial Media Attention

Community Generosity


Dairy Queen
WE CAN NEVER
TAKE FOR
GRANTED THE
SACRIFICE OF
HEROES
Mrs. Foster's
Hornet Pride class
8th


Hemphill High School
GOD BLESS
OUR SPACE FAMILY

CORSICANA

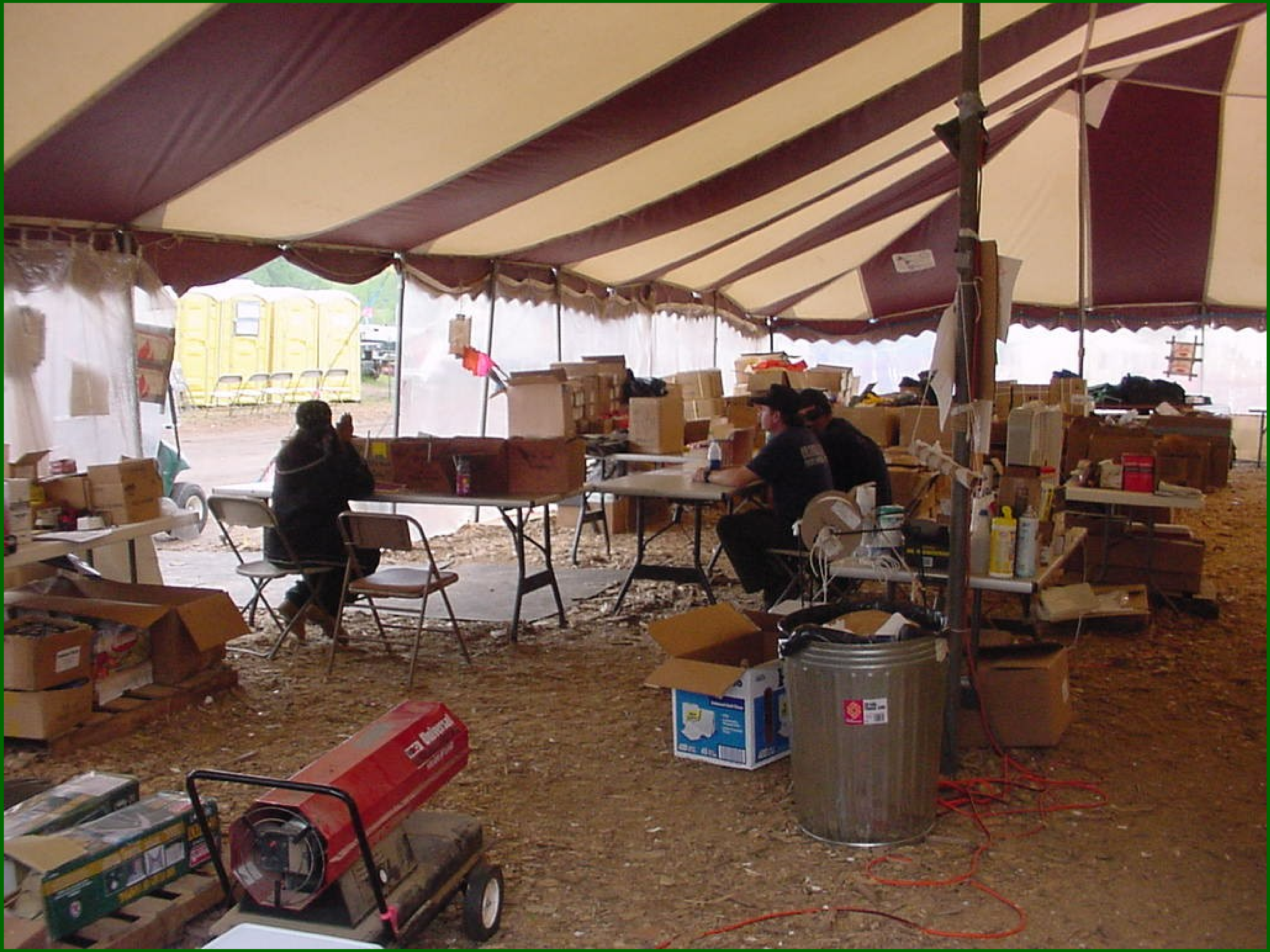


BASE CAMP

All Risk Response Equals All Weather

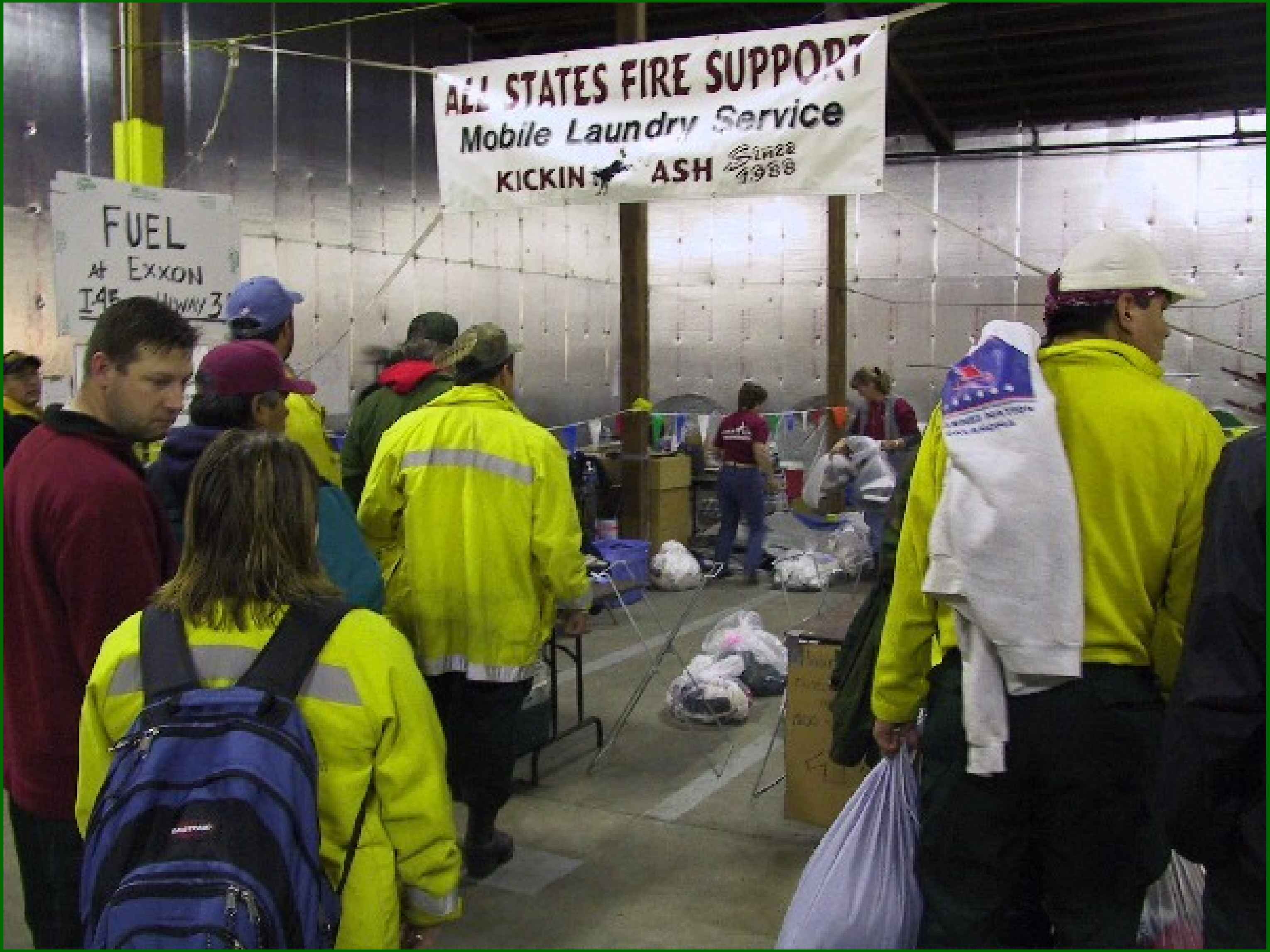
STEWART'S
FIREFIGHTER
FOOD CATERING

Breakfast Chow line

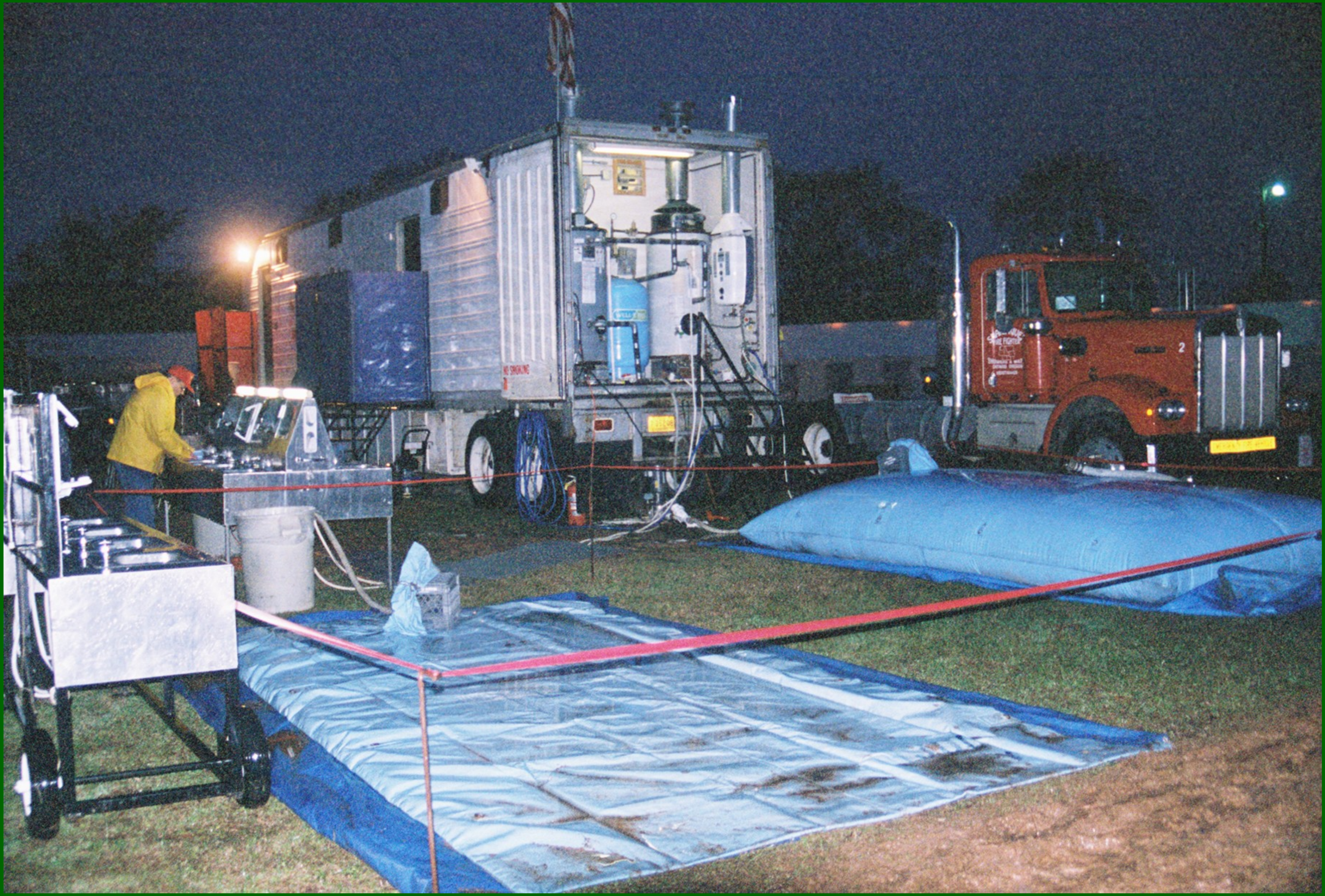


Supply Tent

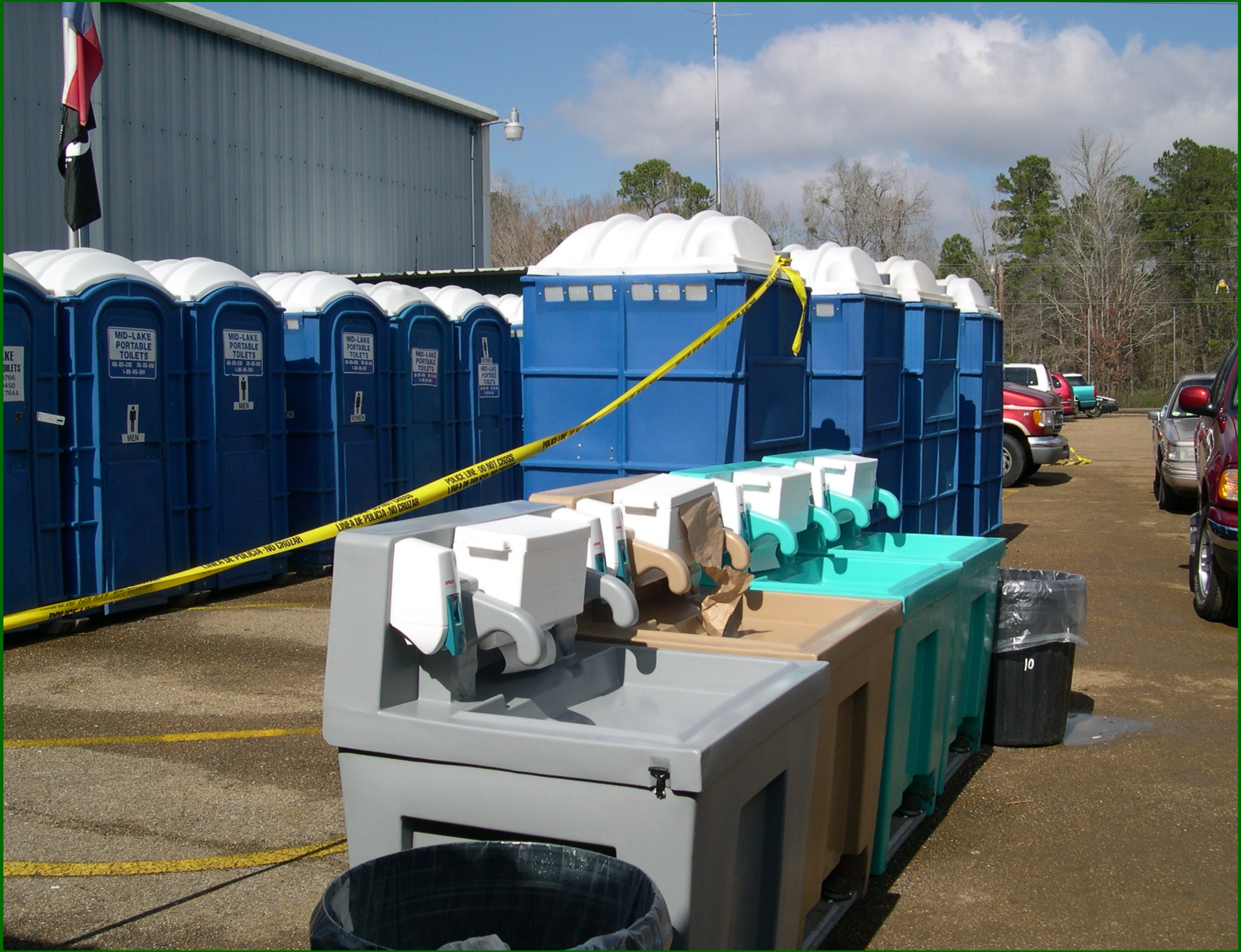
Critical Needs: Dry Boots


ALL STATES FIRE SUPPORT
Mobile Laundry Service
KICKIN ASH
Since 1988
FUEL
At EXXON
I45 Hiway 3

Camp Laundry Service



Shower Unit


MID-LAKE PORTABLE TOILETS
MEN
WOMEN
POLICE LINE DO NOT CROSS
LINEA DE POLICIA - NO CRUZAR
10

Sanitation Facilities

PLANNING
RESOURCES UNIT
EPA

Incident Management Team Planning Meeting

Morning Crew Briefing

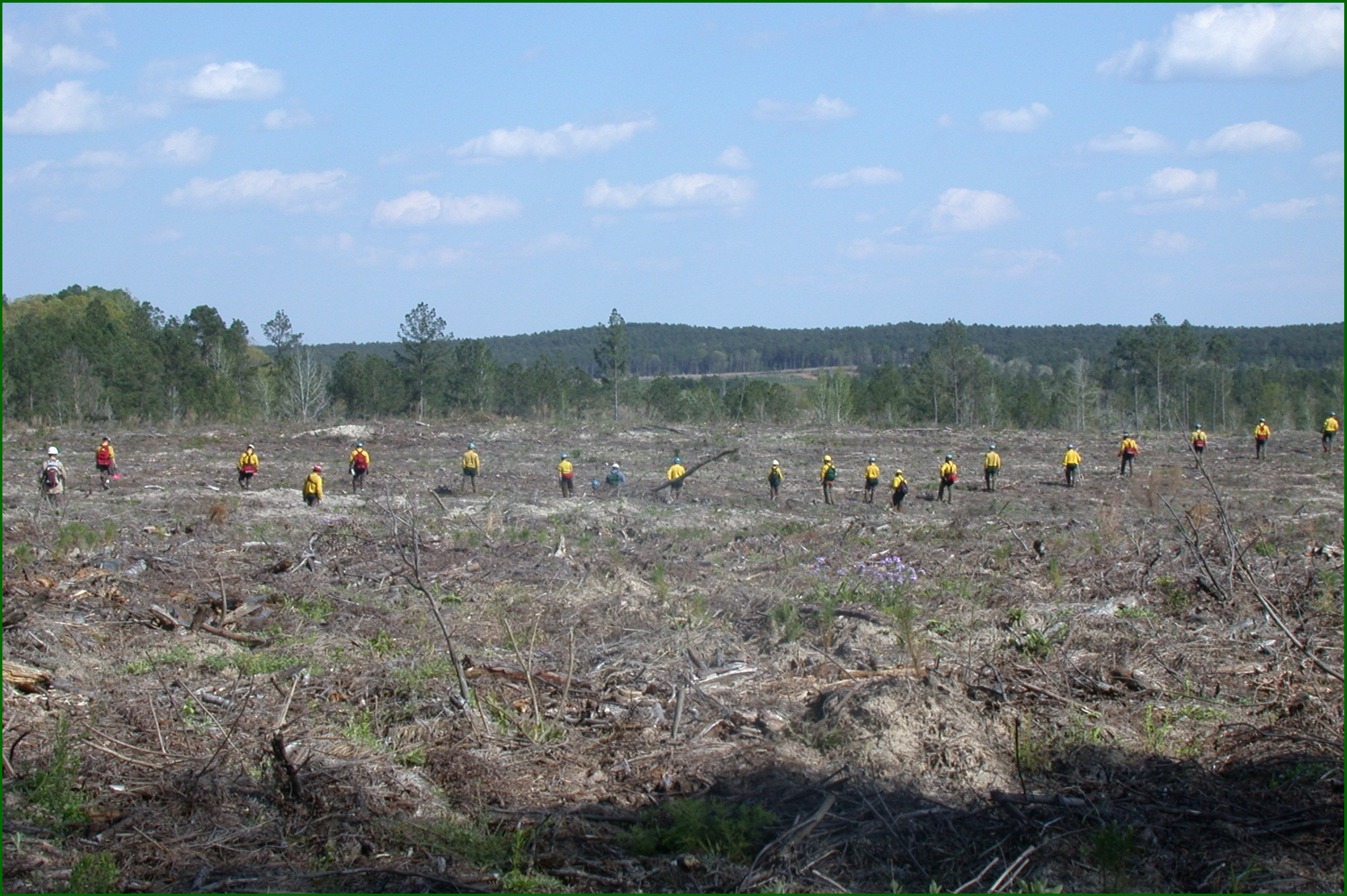
Search and Rescue Crew Training

Planning the Search

Delineating the Grid

GIS Support for the Operation

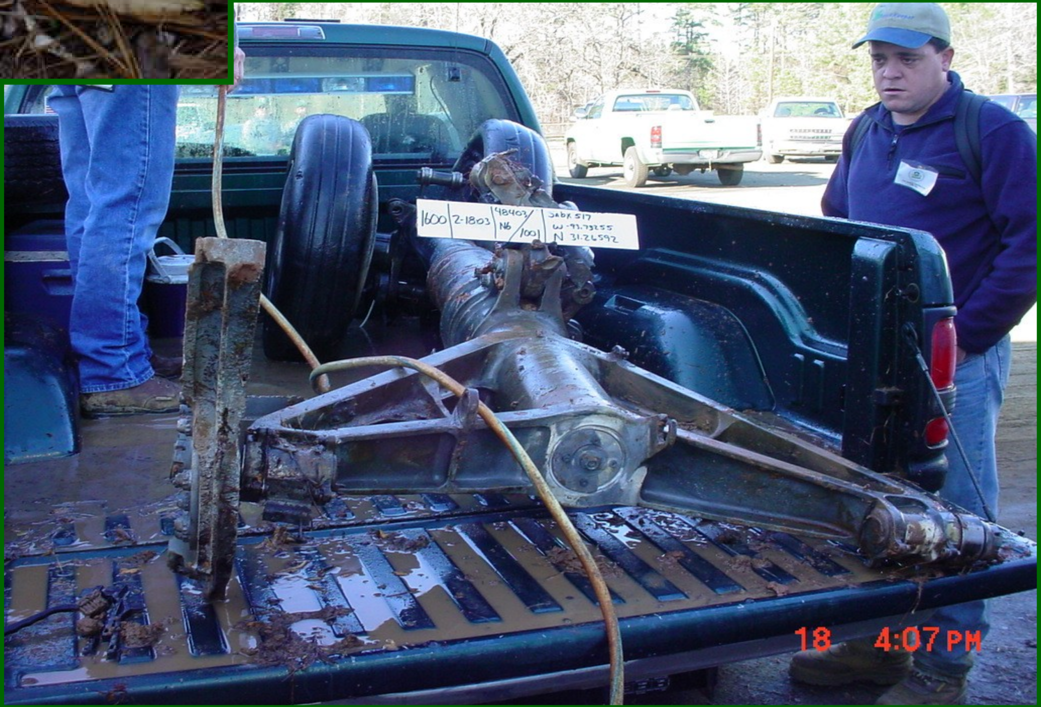
30. 3. 2002 10:58



Crew in Search Formation

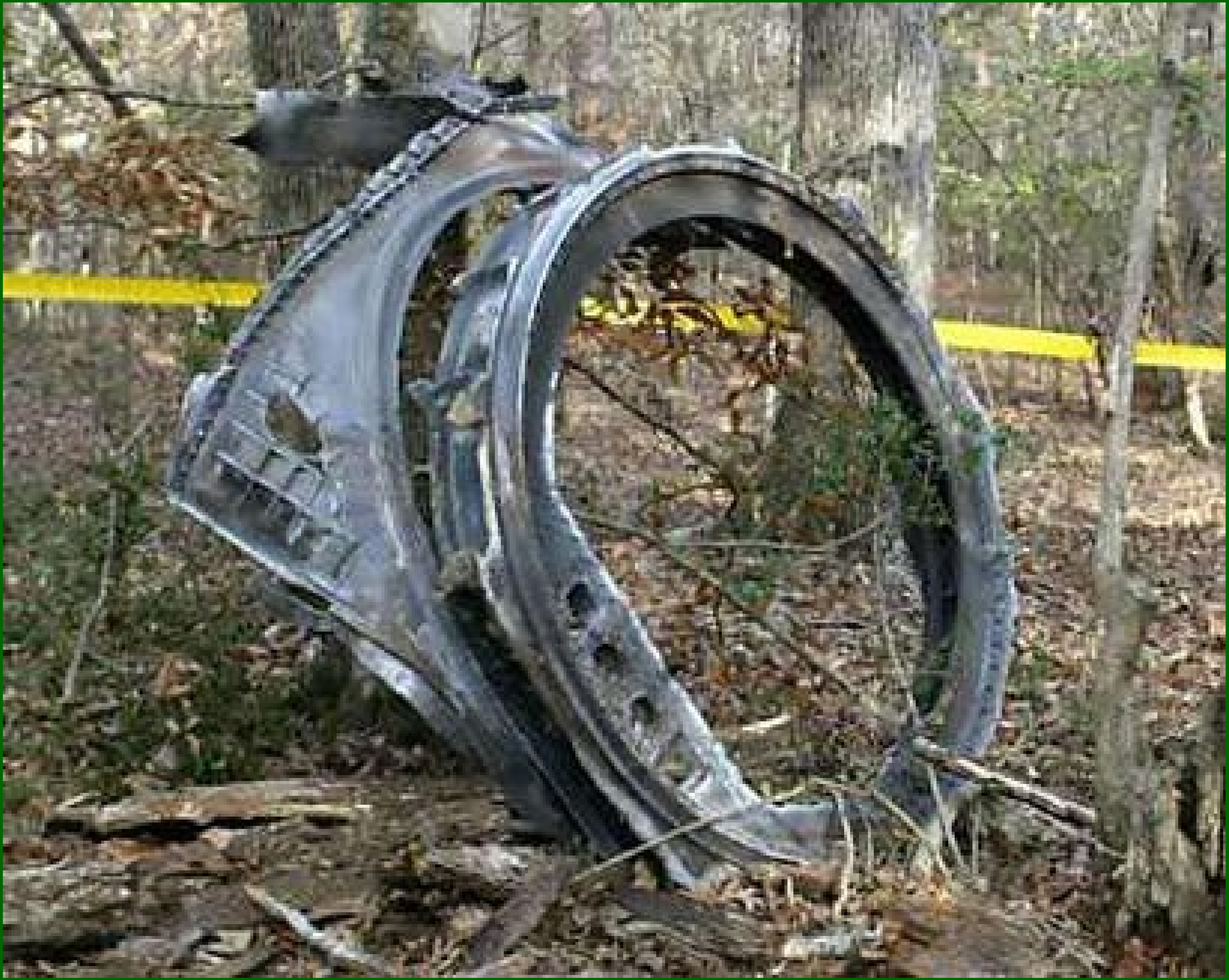
31.34398
-93.97552
48403-01-46

Material Documentation

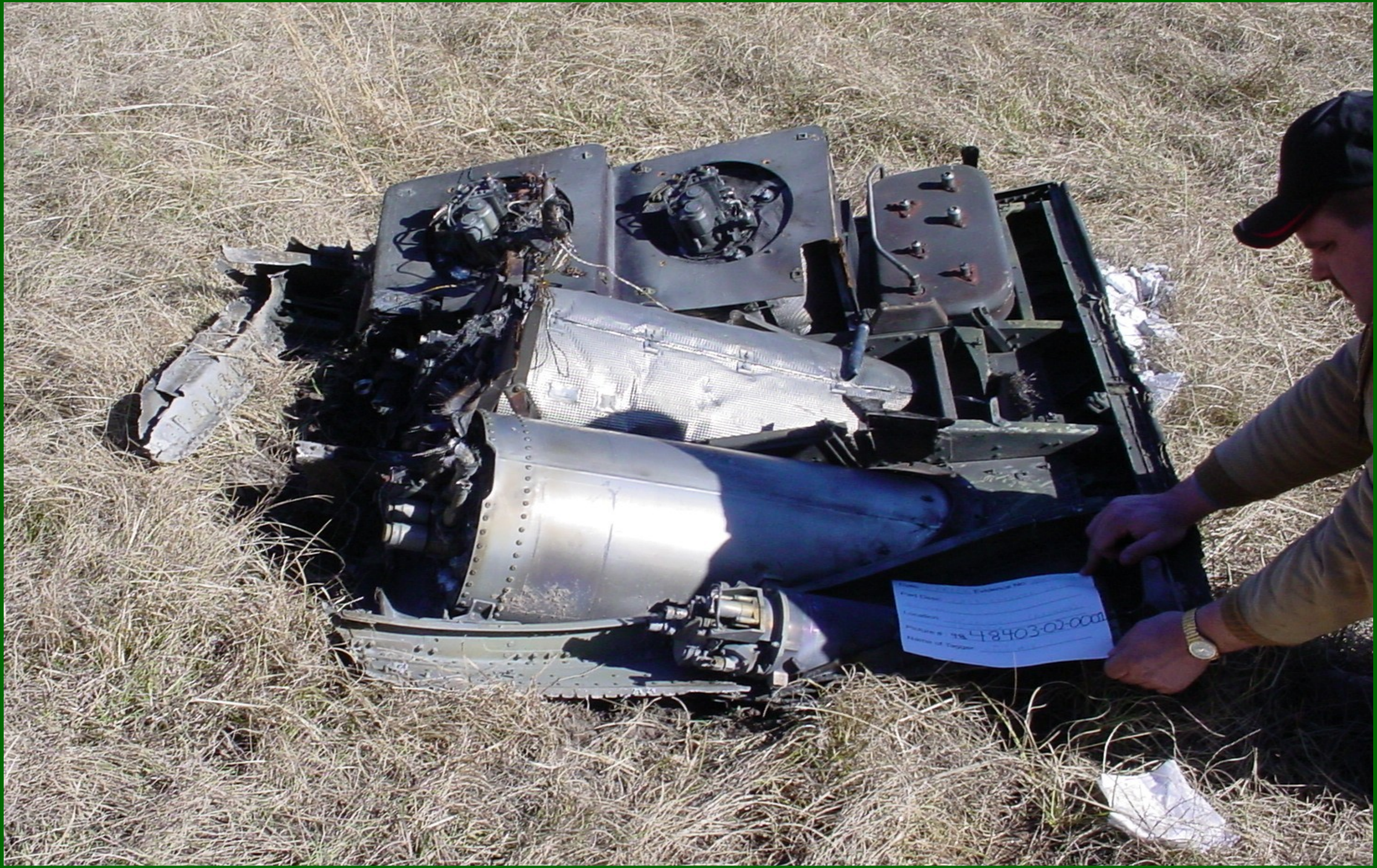

1600
2-18-03
48403/N6
1001
JADX 517
W -93.79255
N 31.26592
18 4:07 PM

Front Landing Gear

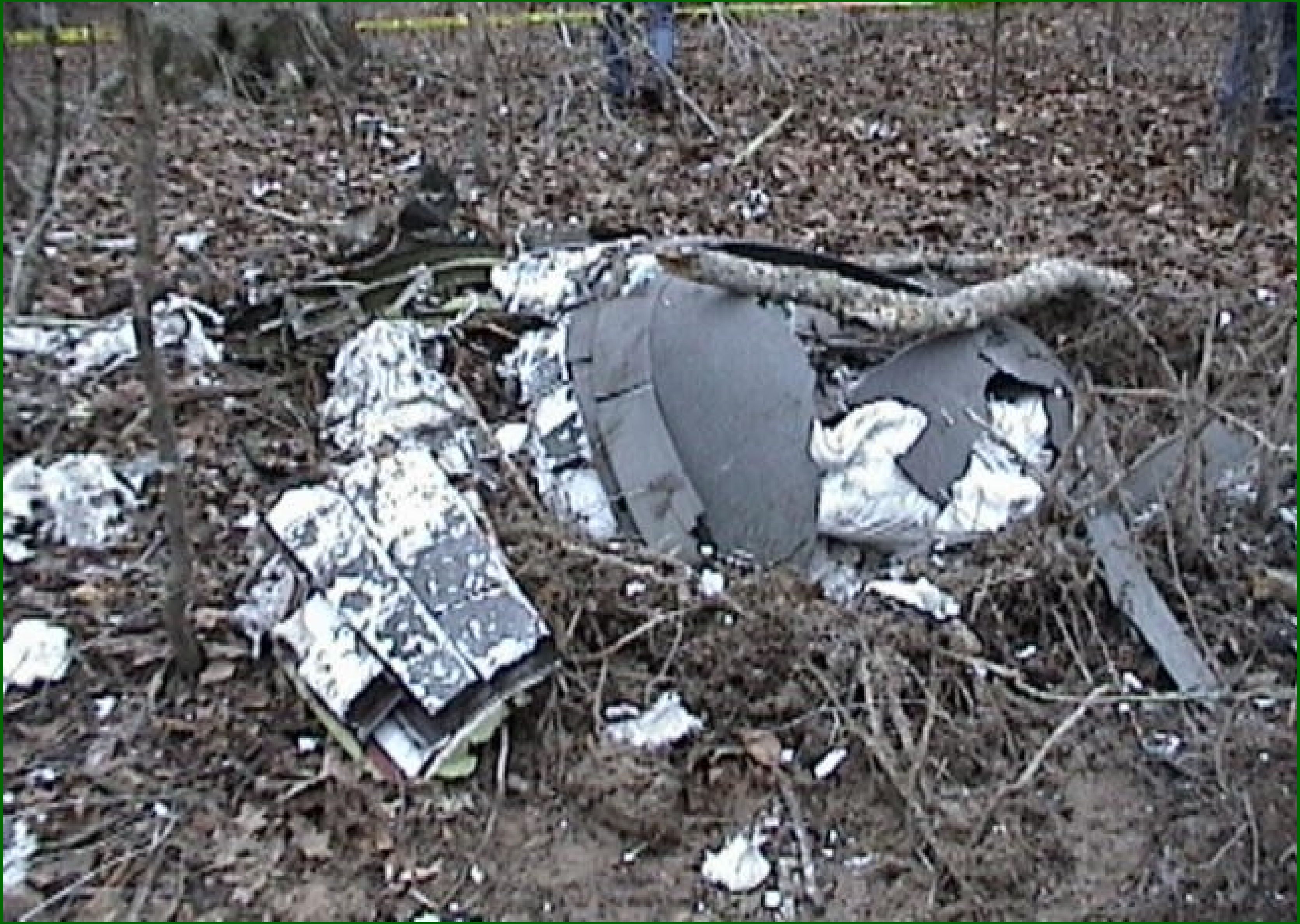
Tile



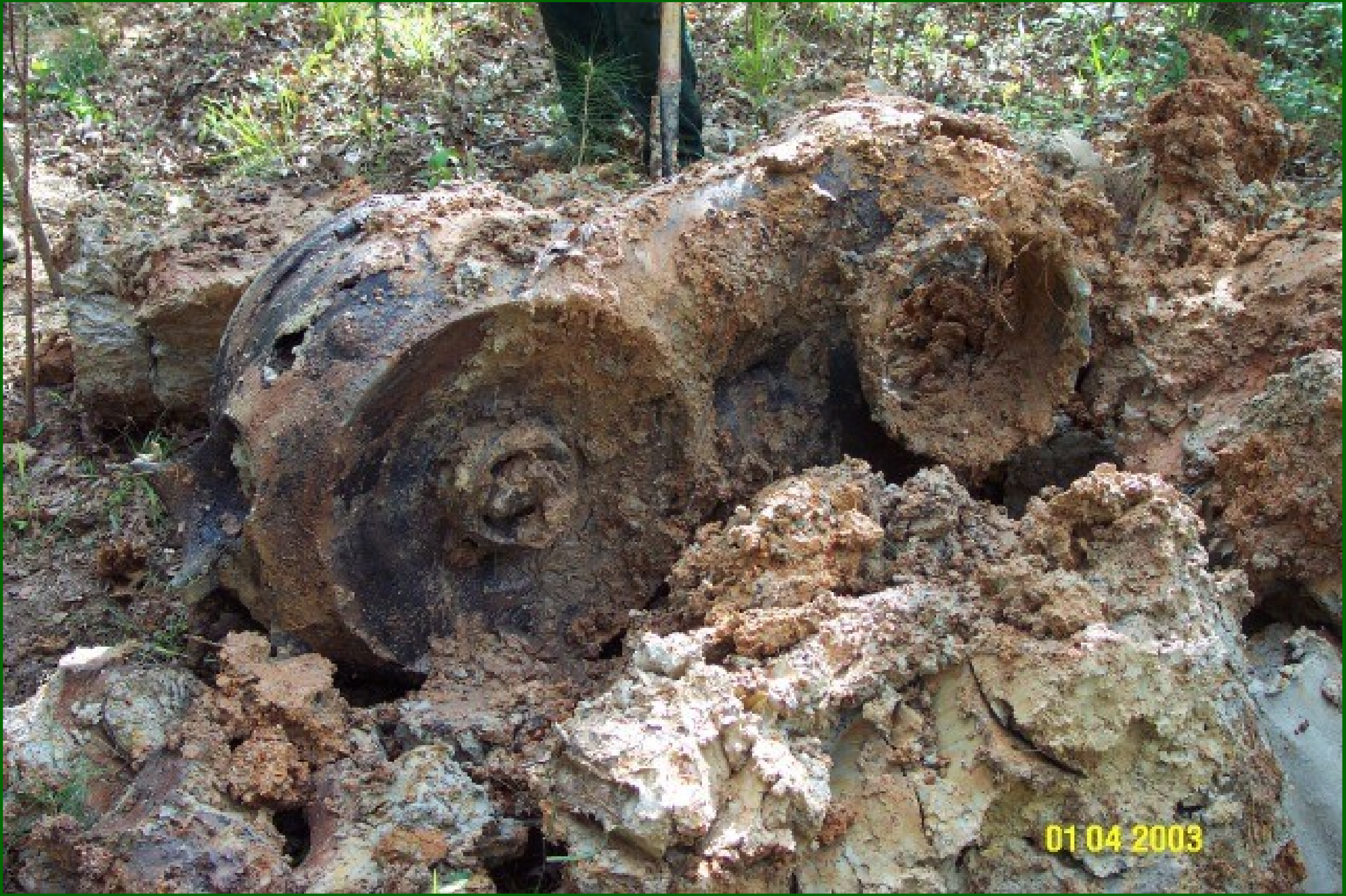
Shuttle Hatch


48403-02-0001

Thruster Structure Assembly



Nose Cone



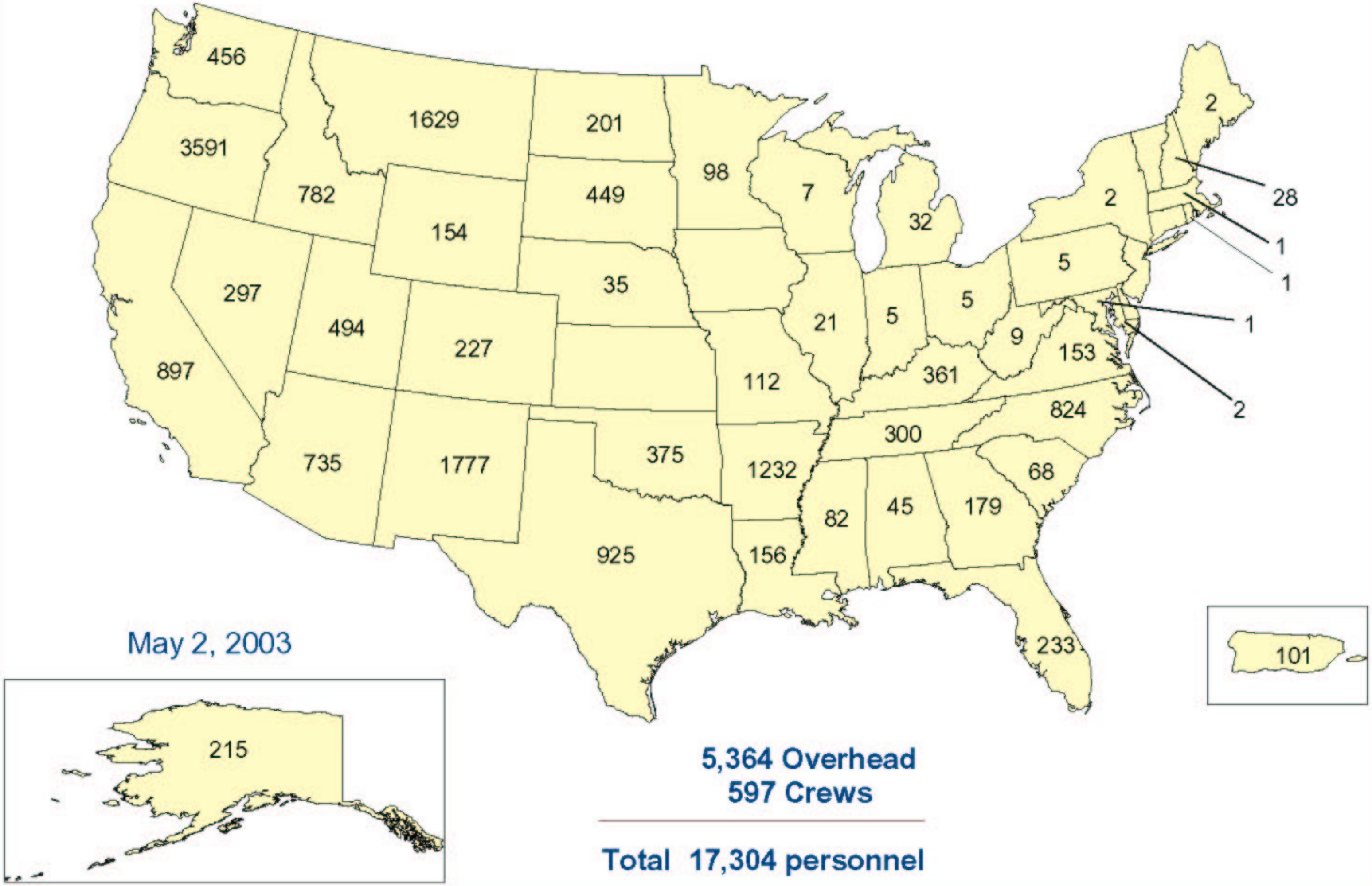
Main Engine Power Head

Ground Search Summary

- Total acres searched – 680,750
- Average acres searched per day – 10,550
- Average acres per searcher per day – 3.64
- Miles traversed by searchers – 552,000
- Average searchers deployed per day – 2,515
- Total man hours searched – 1,529,086

Columbia Disaster Response 2003

NWCG Resources Mobilized through Texas Interagency Coordination Center


456
3591
1629
201
98
7
32
2
28
782
154
449
2
1
1
5
35
297
494
227
21
5
5
1
9
153
897
112
361
2
824
300
375
1232
68
735
1777
82
45
179
925
156
233
101
215

May 2, 2003

5,364 Overhead
597 Crews

Total 17,304 personnel

Air Search

NASA
FEMA
FBI
DEM
DPS
TEXAS TASK FORCE ONE
EPA
2/75 DIV (TS)
USCG
URBAN SEARCH & RESCUE BLUE 1ST
TEXAS NATIONAL GUARD
USFS
TCEQ
NPS
USFWS
TEXAS FOREST SERVICE
BROWN
CLARK
CHAWLA
ANDERSON
RAMON
HUSBAND
MCCOOL
STS 107

- Airborne assets were used both to look fo debris and to guide ground searchers
- Air search was organized using a grid pattern
- Radar data used to establish the primary and secondary search areas
- Tracking records provided by DOD, FAA, and weather radar were analyzed to provide a three dimensional “view” of ballistic debris tracks
- Three helibases were established
- Search area covered 643 grids – 1.6 million acres

Air Search Assets

- DOD and Forest Service Helicopters
- Fixed-wing Aircraft
- EC-47 multispectral equipped aircraft
- EPA aircraft with Spectralimagery capabilities
- DC-3
- Civil Air Patrol
- ER-2 (NASA U-2)
- Motorized P liders
- Ultralights

Air search
in
progress

Water Search

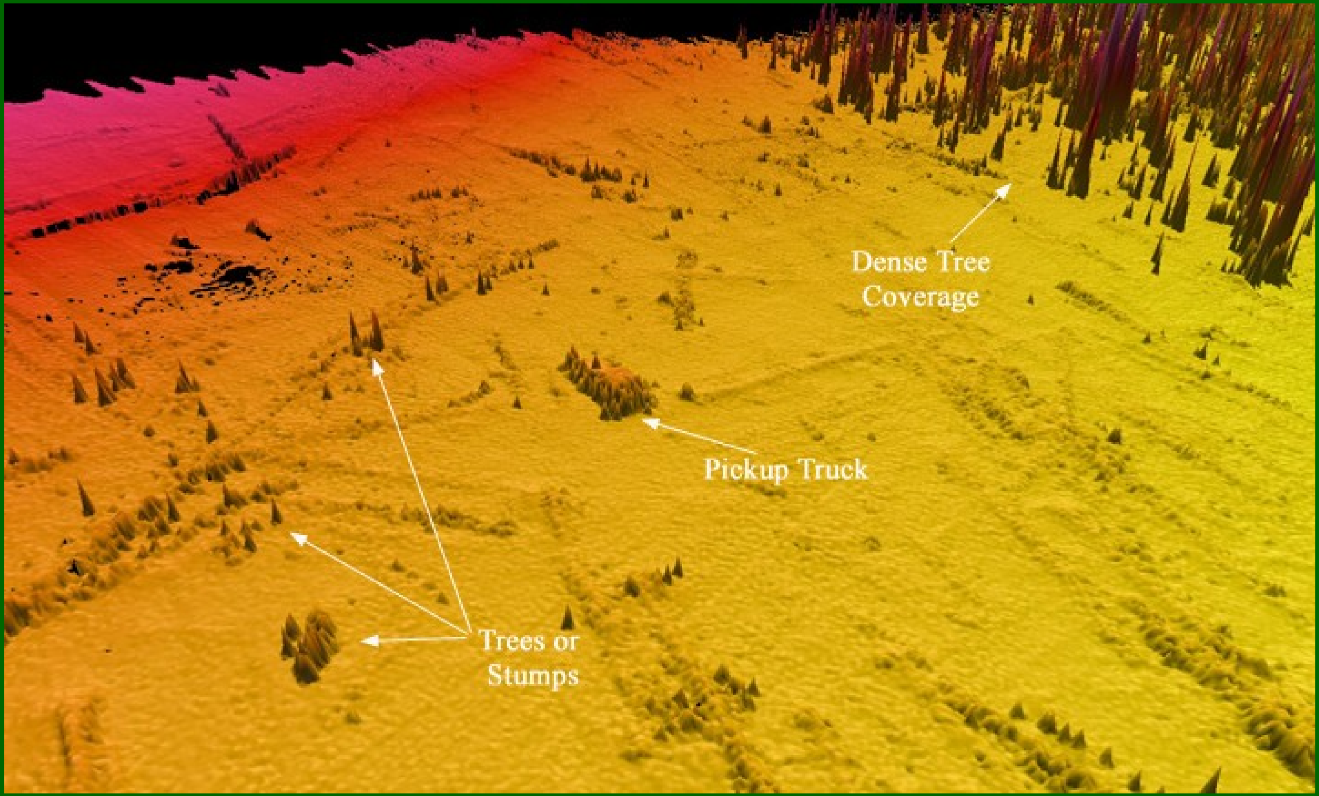
- Toledo Bend Reservoir & Lake Nacogdoche
- 7 dive teams led by USN Supervisor of Salvage
  - Total dives: 3465
  - Total bottom time: 800 hours
  - 13 boats
- Sonar operations: side-scan, multi-beam, hand-held
  - Total area scanned: 23 sq. mi.
  - 10 boats
- Autonomous Underwater Vehicle
- 12 additional security boats

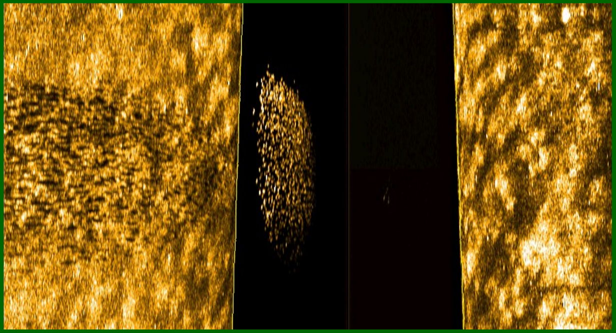
TEXAS DPS
DIVE RECOVERY TEAM
EVINRUDE

Dive teams working in Toledo Bend Reservoir

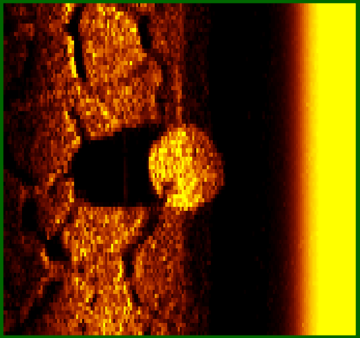
327001
U.S. COAST GUARD

Multi-beam Digital Terrain Model

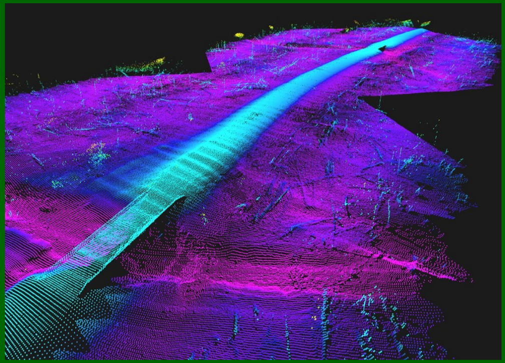

Dense Tree Coverage
Pickup Truck
Trees or Stumps



School of Fish

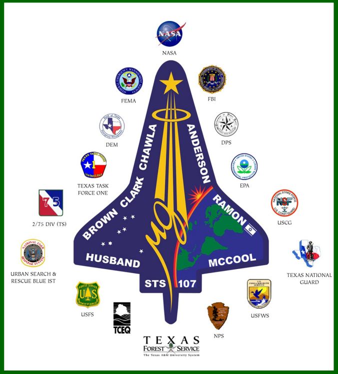


5 Gal. Bucket



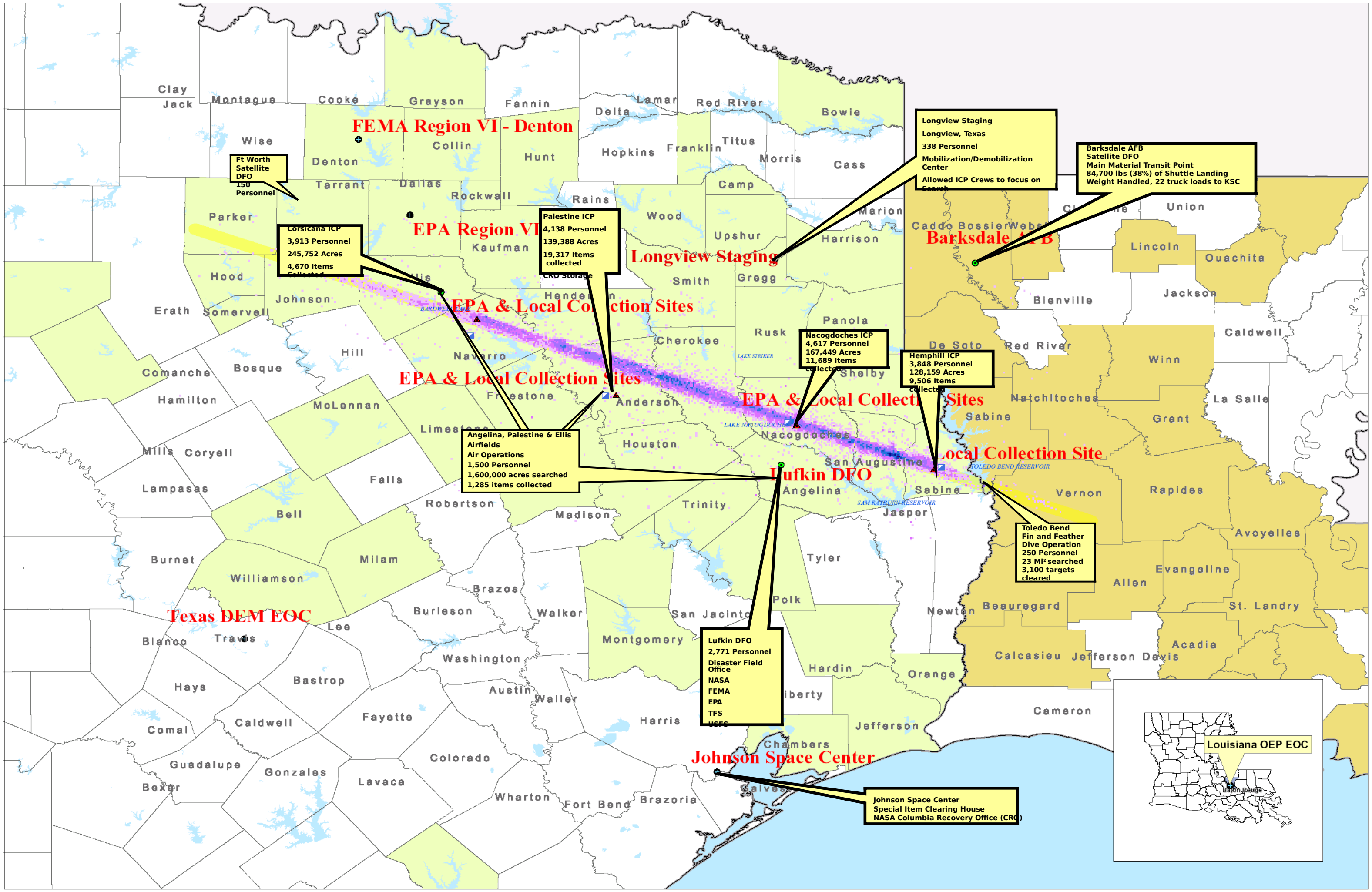
RESON 8125 Edited Points File Image

Columbia Recovery Summary


NASA
FEMA
FBI
DEM
DPS
TEXAS TASK FORCE ONE
EPA
2/75 DIV (TS)
USCG
URBAN SEARCH & RESCUE BLUE IST
TEXAS NATIONAL GUARD
USFS
TCEQ
NPS
USFWS
TEXAS FOREST SERVICE
The Texas A&M University System
BROWN CLARK CHAWLA
ANDERSON
RAMON
HUSBAND
MCCOOL
STS 107

- First incident under new DHS
- Largest search in history
- 100 days of continuous operation
- Substantial interagency, intergovernmental, cross-sector response
- 450 organizations and 25,000 responders
- Largest GIS effort (30,000 maps)
- 20 national Incident Management Teams and almost 600 crews mobilized
- More than 82,500 pieces of material recovered
- 84,700 lbs of the total re-entry weight (222,900 lbs) of Shuttle Columbia recovered to date – 38%

COLUMBIA SHUTTLE RECOVERY OPERATIONS SUMMARY


FEMA Region VI - Denton
EPA Region VI
Longview Staging
Barksdale AFB
EPA & Local Collection Sites
EPA & Local Collection Sites
EPA & Local Collection Sites
Local Collection Site
Lufkin DFO
Texas DEM EOC
Johnson Space Center
BARDWELL LAKE
LAKE STRIKER
LAKE NACOGDOCHES
TOLEDO BEND RESERVOIR
SAM RAYBURN RESERVOIR
Clay
Jack
Montague
Cooke
Grayson
Fannin
Lamar
Red River
Bowie
Delta
Wise
Denton
Collin
Hunt
Hopkins
Franklin
Titus
Morris
Cass
Tarrant
Dallas
Rockwall
Rains
Camp
Wood
Upshur
Marion
Harrison
Parker
Kaufman
Hood
Johnson
Ellis
Henderson
Smith
Gregg
Erath
Somervell
Panola
Rusk
Hill
Navarro
Cherokee
Shelby
Comanche
Bosque
Hamilton
McLennan
Freestone
Anderson
Nacogdoches
Limestone
Houston
San Augustine
Mills
Coryell
Falls
Angelina
Sabine
Lampasas
Robertson
Trinity
Jasper
Bell
Madison
Burnet
Milam
Tyler
Williamson
Brazos
Polk
Burleson
Walker
San Jacinto
Newton
Lee
Blanco
Travis
Montgomery
Washington
Hardin
Orange
Bastrop
Austin
Waller
Liberty
Hays
Harris
Comal
Caldwell
Fayette
Jefferson
Chambers
Guadalupe
Gonzales
Colorado
Bexar
Lavaca
Wharton
Fort Bend
Brazoria
Galveston
Caddo
Bossier
Webster
Claiborne
Union
Lincoln
Ouachita
Bienville
Jackson
Caldwell
De Soto
Red River
Winn
Natchitoches
La Salle
Sabine
Grant
Vernon
Rapides
Avoyelles
Evangeline
Allen
Beauregard
St. Landry
Acadia
Calcasieu
Jefferson Davis
Cameron
Louisiana OEP EOC
Baton Rouge

Ft Worth
Satellite
DFO
150
Personnel

Corsicana ICP
3,913 Personnel
245,752 Acres
4,670 Items
Collected

Palestine ICP
4,138 Personnel
139,388 Acres
19,317 Items
collected
CRO Storage

Longview Staging
Longview, Texas
338 Personnel
Mobilization/Demobilization Center
Allowed ICP Crews to focus on Search

Barksdale AFB
Satellite DFO
Main Material Transit Point
84,700 lbs (38%) of Shuttle Landing
Weight Handled, 22 truck loads to KSC

Nacogdoches ICP
4,617 Personnel
167,449 Acres
11,689 Items
collected

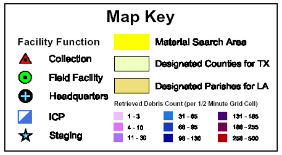
Hemphill ICP
3,848 Personnel
128,159 Acres
9,506 Items
collected

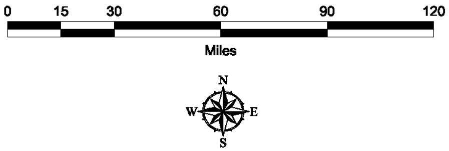
Angelina, Palestine & Ellis
Airfields
Air Operations
1,500 Personnel
1,600,000 acres searched
1,285 items collected

Toledo Bend
Fin and Feather
Dive Operation
250 Personnel
23 Mi² searched
3,100 targets
cleared

Lufkin DFO
2,771 Personnel
Disaster Field Office
NASA
FEMA
EPA
TFS
USFS

Johnson Space Center
Special Item Clearing House
NASA Columbia Recovery Office (CRO)


Map Key
Facility Function
Collection
Field Facility
Headquarters
ICP
Staging
Material Search Area
Designated Counties for TX
Designated Parishes for LA
Retrieved Debris Count (per 1/2 Minute Grid Cell)
1 - 3
4 - 10
11 - 30
31 - 65
66 - 95
96 - 130
131 - 185
186 - 255
256 - 500


0
15
30
60
90
120
Miles
N
W
E
S

CONTACT INFORMATION

Columbia Shuttle Disaster
East Texas Federal Response
Lufkin Emergency Operations Center
415 S First Street
Lufkin, Texas 75901

Production
Date: May 04, 2003
By: A Springett

GIS/Planning Section - (936) 699 - 1077

Return to Flight Strategy

- Figure out what happened
- Fix it
- Get back to flight

Columbia Accident Investigation

NASA
FEMA
FBI
DEM
DPS
TEXAS TASK FORCE ONE
EPA
2/75 DIV (TS)
USCG
URBAN SEARCH & RESCUE BLUE 1ST
TEXAS NATIONAL GUARD
CHAWLA
ANDERSON
CLARK
BROWN
RAMON
HUSBAND
MCCOOL
STS 107
USFS
TCEQ
NPS
USFWS
TEXAS FOREST SERVICE

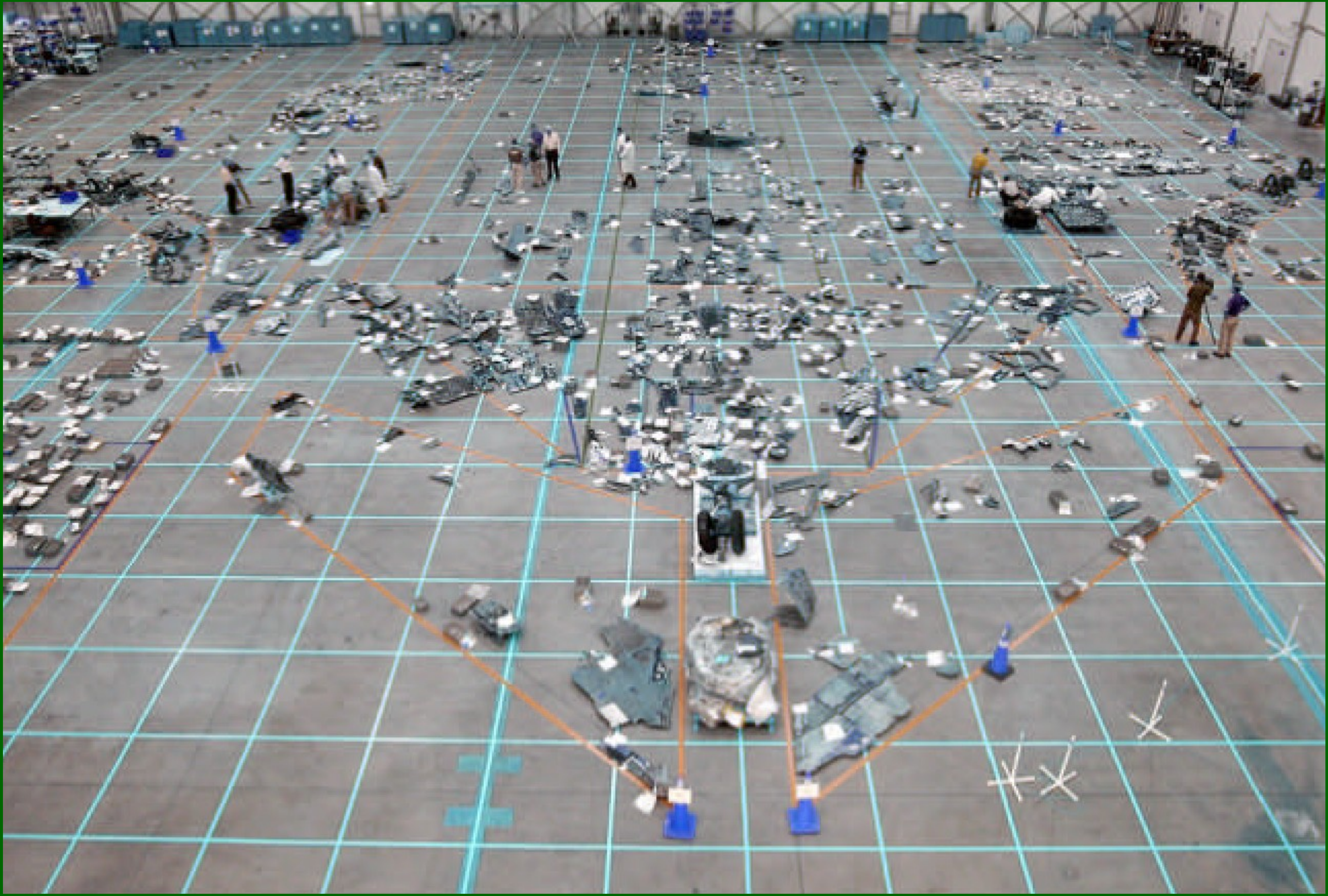
- CAIB convened by NASA Administrator
  75 minutes after loss of contact
- CAIB responsible for the investigation of the accident
- CAIB anticipates final report will be released by August
- NASA supporting CAIB with data, engineering analysis
- CAIB tasked by the NASA Administrator to:
  1. Independently determine the facts surrounding the accident.
  2. Determine the actual or probable causes of the accident.
  3. Document findings in terms of dominate and contributing root causes and significant observations.
  4. Recommend preventative or other appropriate actions to preclude recurrence of a similar nature.
  5. Have a final report as soon as practical.

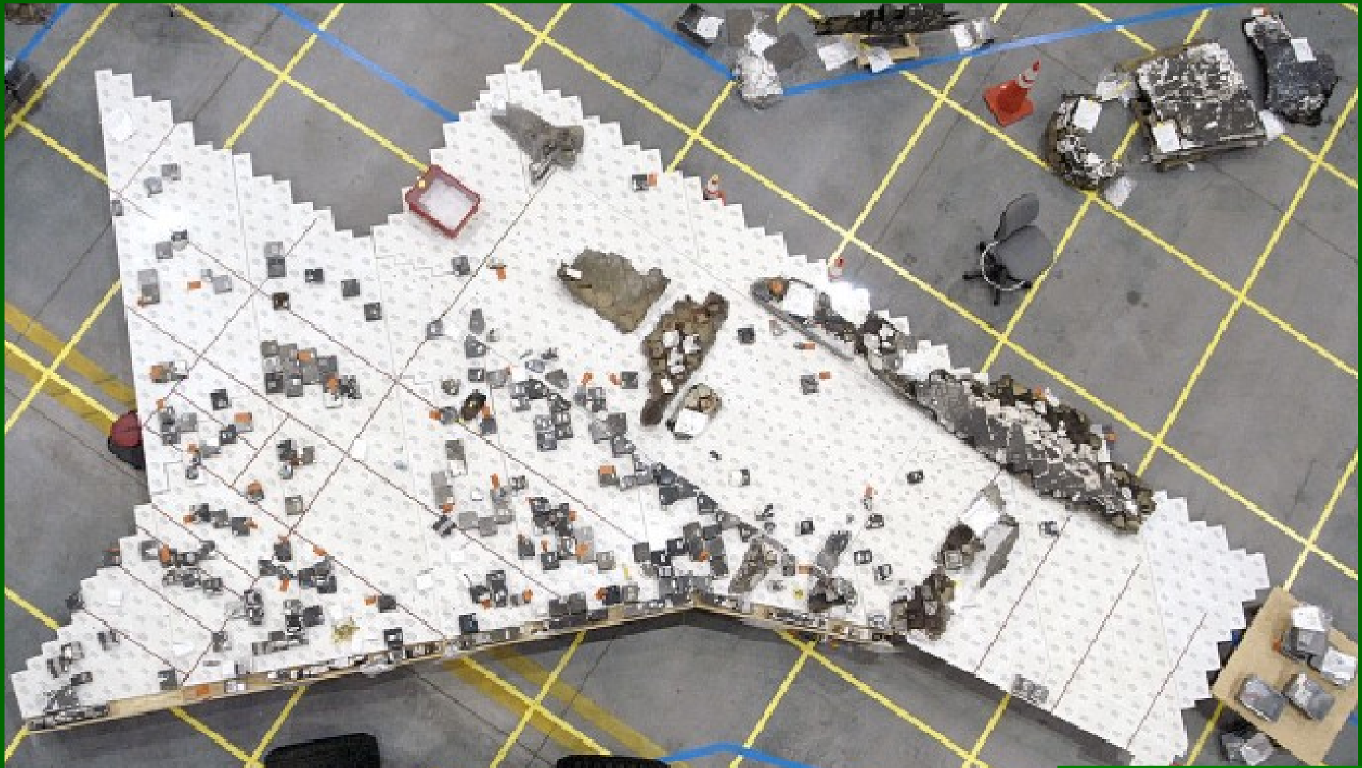
Materials Prepared for Shipment to Barksdale AFB

Material Processing Area

Barksdale Air Force Base

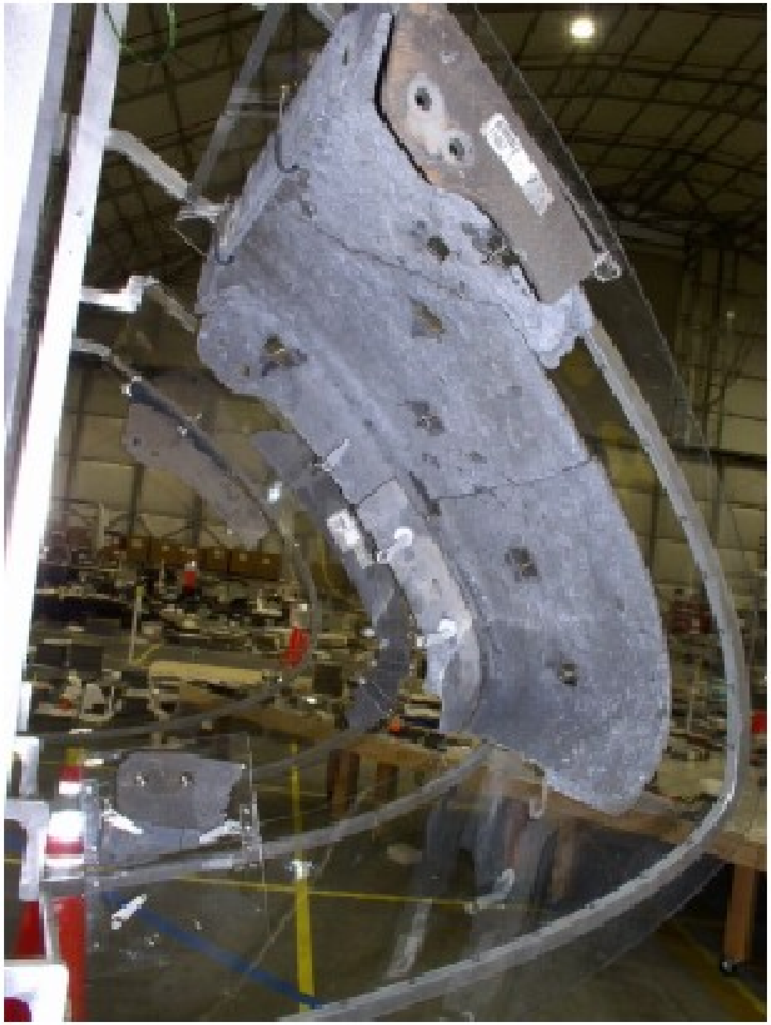
Reconstruction Efforts at Kennedy



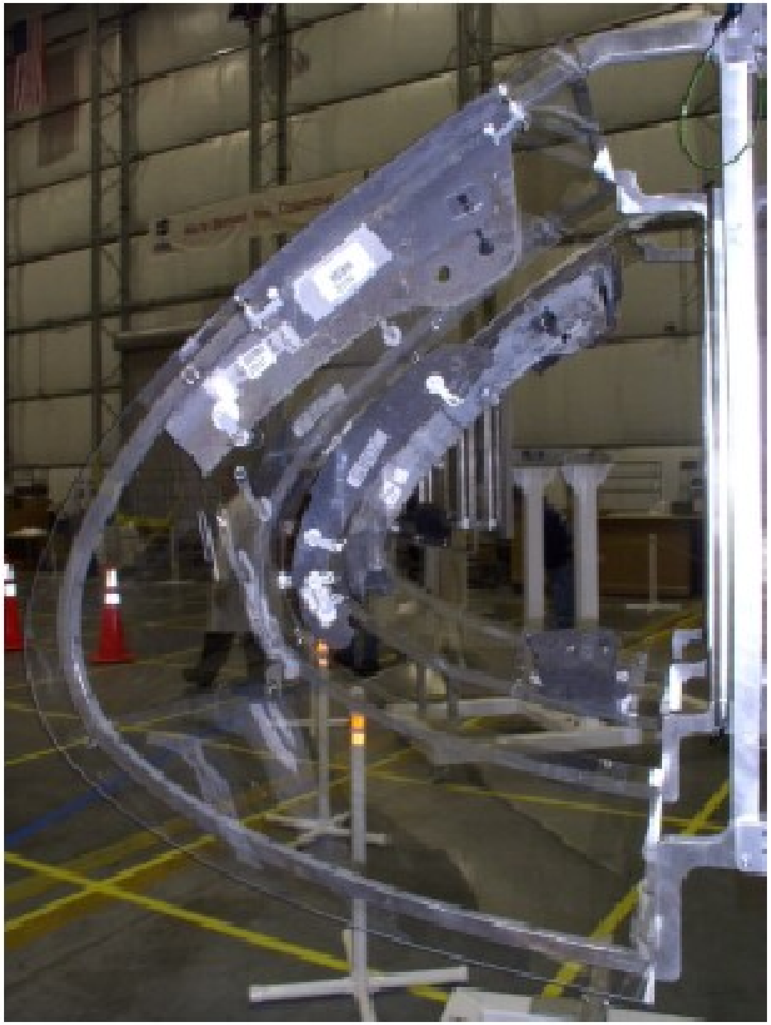


Left Hand Wing Tile

Tile Table Layout



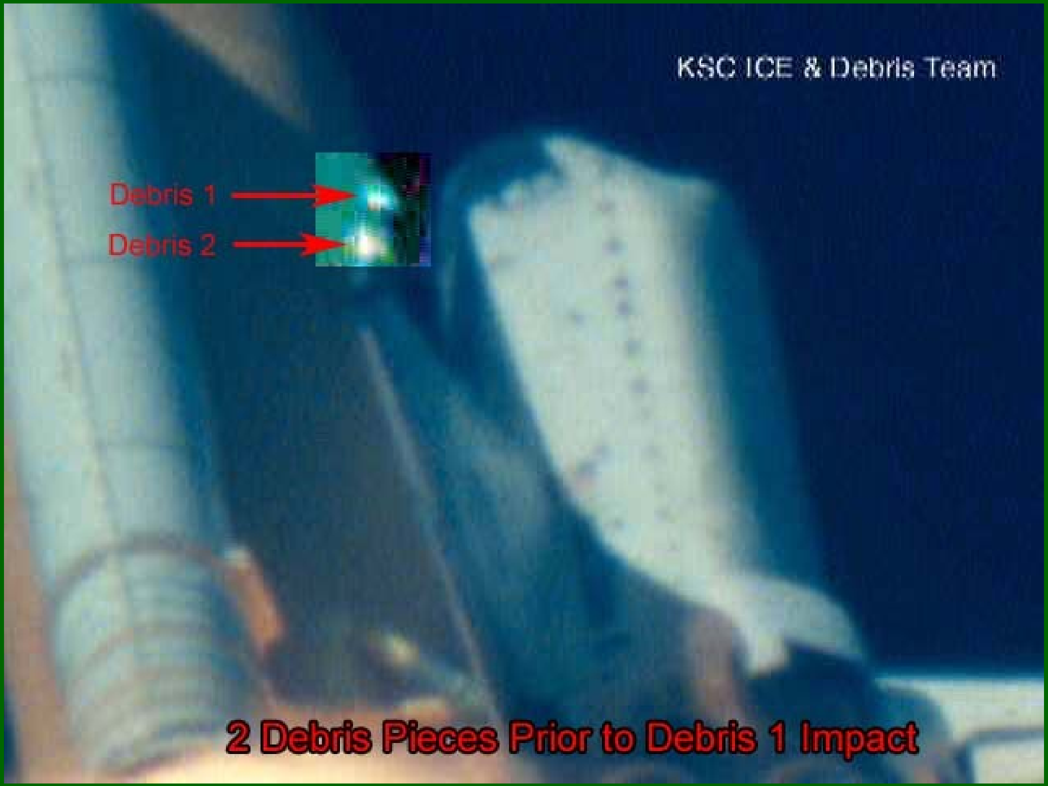
RCC Panel 8 Fixture Rear View



RCC Panel 9 Fixture Rear View

CAIB Working Scenario – As Of May

- The CAIB has released their working scenario for the Columbia accident, after 3 months of intense investigation.
- Preliminary conclusions are divided into three phases of Columbia’
  1. Ascent
  2. Orbit
  3. Entry


KSC ICE & Debris Team
Debris 1
Debris 2
2 Debris Pieces Prior to Debris 1 Impact

CAIB Working Scenario – As Of May

- Ascent: 81 sec. after launch foam from the left bipod ramp area impacted the bottom left wing.
- On-Orbit: No indication of damage based on telemetry, downlinked video, still photography, or crew reports.
- USAF post flight evaluation of radar tracking data indicated an object departed the orbiter on flight day 2.
- Entry: on Feb 1, Columbia entered with unknown damage to an RCC panel or T-seal in the left wing.
- Hardware forensic evidence indicates that the panel 8/9 area was subjected to extreme entry heating over a long period of time leading to

Why The Recovery Succeeded

- High-quality, capable, compatible people
- Clearly articulated missions with universal buy-in
- Transparency of leadership built trust
- Negotiation of competing missions
- Lack of “turf” struggles
- Constituent units empowere
- Community generosity
- Local capability
- Explicit attention to morale
- Openness of physical space

LONE STAR
564-9800
INCIDENT COMMANDER
NASA
DOM GORIE

What We Should Learn

NASA
FEMA
FBI
DEM
DPS
TEXAS TASK FORCE ONE
EPA
2/75 DIV (TS)
USCG
URBAN SEARCH & RESCUE BLUE 1ST
TEXAS NATIONAL GUARD
USFS
TCEQ
NPS
USFWS
TEXAS FOREST SERVICE
BROWN
CLARK
CHAWLA
ANDERSON
RAMON
HUSBAND
MCCOOL
STS 107

- Do not compromise on planning and trainin
- Institutionalize learning mechanisms
- Close the feedback loop between operations and analysis
- Facilitate flexibility, agility, and a proactive stance
- Develop a “plug-and-play” interagency process
- Formalize and professionalize incident management
- Adopt and communicate uniform conventions early
- Vest authority for and specify key architectures early
- Build habitual relationships proactively
- Some functions are better centralized; others

THE CAUSE of exploration and discovery is not an option we choose; it is a desire written in the human heart. We are that part of creation which seeks to understand all creation. We find the best among us, send them forth into unmapped darkness, and pray they will return. They go in peace for all mankind, and all mankind is in their debt.

Our journey into space will go on.

Return to Flight

Return to Flight Status

- The outcome of the CAIB investigation may drive changes in vehicle design and processing for implementation prior to return-to-flight, STS-114.
- To date, the CAIB has issued two Preliminary Recommendations:
    1. Develop and implement a comprehensive inspection plan to determine the structural integrity of all RCC system components. This inspection plan should take advantage of advanced non-destructive inspection technology.
    2. Modify NASA’ s Memorandum of Agreement with NIMA, to make on-orbit imaging for each Shuttle flight a standard requirement.

Return to Flight Status

In addition to the CAIB findings, the Shuttle Program has initiated the following efforts:

- Changes to the ET insulation design that could preclude any loss of insulation
- Evaluate on-orbit inspection techniques and repair options
- Review existing launch viewing assets and capabilities, and recommend improvements
- Identify options to obtain flight-based photographic coverage of critical launch and ascent activities and environments, including ET and SRB camera devices
- Review trajectory options that could minimize entry heating, if any.

Space Shuttle Program Status

- All Shuttle missions are on hold pending completion of the investigation and determination of cause of the accident.
- Projected flight rate of 5/yr prior to the loss of Columbia will be reassessed during the return-to-flight evaluation.
- ISS assembly and Hubble Telescope servicing missions can be accomplished with the 3 remaining Orbiters.
- Discovery is undergoing a major modification in Orbiter Processing Facility #3, including structural inspections and incorporation of upgrades (completion expected April 2004).
- Atlantis was stacked in preparation for STS-114. It has been demated from the External Tank in the Vertical Assembly Building and returned to OPF-1.
- Endeavour is undergoing normal processing in OPF-2 in preparation for its next flight, STS-115.

ISS Status: Expedition 6 Crew R

- Soyuz TMA-1 returned Expedition 6 Crew May 3, 2003.
- Returned on Ballistic entry mode, backup to Controlled Descent mode (reason under investigation).
- Entry was nominal-landed in Ballistic landing zone in Kazakhstan, Russia.
- Search forces diverted to Ballistic zone from

ISS Status: Expedition 7

- Yuri Malenchenko, Cdr (Russia
- Ed Lu, Flight Engineer (US)
- Launched Soyuz TMA-2 April 25, 2003
- Planned on-board science experiments continuing
- Planned crew rotation, Soyuz TMA-3, October 2003
- The ISS crew life support and supplies adequate through June 2003
- Russian Progress supply vehicle 11P launch